BRUSH

OPERATING INSTRUCTIONS

oscillograph
models RD 2682 00, RD 2662 00
and RD 2661 00

MP MASTER
MA34681

This instruction book applies to
Model RD 2661 00 Serial No. 63 and above;
Model RD 2662 00 Serial No. 72 and above;
Model RD 2682 00 Serial No. 144 and above.

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■ If any fault develops

1. Notify the nearest factory branch service station, address on the next page, giving full details of the difficulty, and include the model number, type number and serial number. Upon receipt of this information, we will give you service instructions or issue a material return authorization card.
2. You may request any necessary instrument packaging by telling us what cartons you need. These will be sent to you no charge.
3. Upon receipt of shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

WARRANTY

Each instrument manufactured by Brush Instruments, Division of Clevite Corporation, is warranted to be free from defects in material and workmanship and to operate in accordance with the published specifications when used with the recommended Brush associate equipment and with Brush chart paper. Liability under this warranty is limited to servicing or adjusting any instrument returned to a factory branch service station for that purpose and to replacing any defective parts thereof except tubes, fuses, and batteries.

This warranty is effective for one year after delivery to the original purchaser. When the instrument is returned transportation charges are to be prepaid by the original purchaser. If defective operation has been caused by misuse or abnormal conditions of operation, repairs will be billed at our current rate. In this case an estimate will be submitted before work is started.

SUPPLIES AND SERVICE

Brush Instruments factory branch offices and service stations:

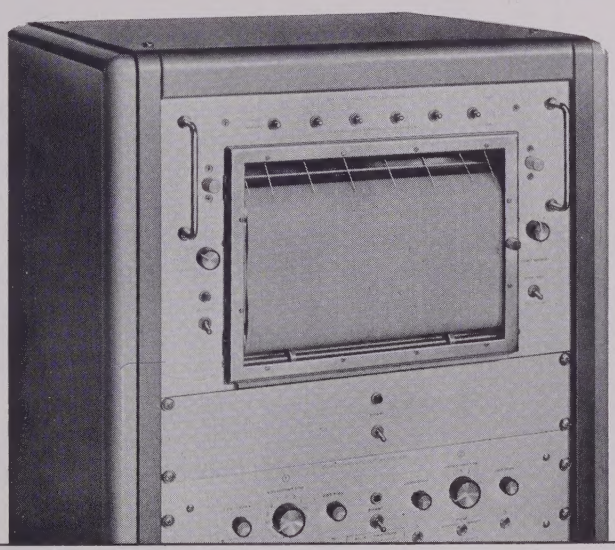
CLEVELAND
Mid-West
3405 Perkins Avenue
Cleveland 14, Ohio
Phone: ENdicott 1-3315

LOS ANGELES
West Coast
1960 So. La Cienega Blvd.
Los Angeles 34, California
Phone: TExas 0-7517

ARLINGTON
East Coast
561 - 23rd St., South
Arlington 2, Virginia
Phone: OTis 4-5912

BOSTON
New England
677 Worcester Street
Natick, Massachusetts
Phone: OLympic 3-8850

EIGHT CHANNEL COMBINATION OSCILLOGRAPH Model RD 2682 00
SIX CHANNEL COMBINATION OSCILLOGRAPH Model RD 2662 00
and
SIX CHANNEL OSCILLOGRAPH Model RD 2661 00



Six Channel Combination Oscillograph Model RD 2662 00, Mounted in Rack Model RA 1152 60.

These direct writing curvilinear oscillographs provide a means of recording instantaneously in permanent form, for study and analysis, the amplitude and frequency of variables that can be translated into an electrical signal. These oscillographs permit the observation of six or eight such phenomena simultaneously. When matched with Brush amplifiers, they provide a flat frequency response from d.c. to 100 cps. Models RD 2682 00 and RD 2662 00 write with either ink pens or electric styli, while the Model RD 2661 00 writes only with ink pens.

Recording on one chart paper facilitates time correlation of the phenomena being recorded. In operation, the chart paper with all six or eight channels rolls downward across the writing table and is clearly visible for a distance of approximately 6". There is no "blind spot" on the chart paper as the tips of the pens or styli may be seen as they are deflected. An internal take up is provided for rerolling a full roll of recorded chart paper.

An eight speed transmission provides chart paper speeds of 1, 2, 5, 10, 25, 50, 125, and 250 *millimeters per second.* When the unit is equipped with an accessory Slow Speed Motor, eight additional chart paper speeds are available in the same multiples but at *centimeters per hour.* Accessory Event Markers, as well as Slow and Fast Marker Units, are available. A complete description of all accessories will be found in Section IV, under "ACCESSORIES".

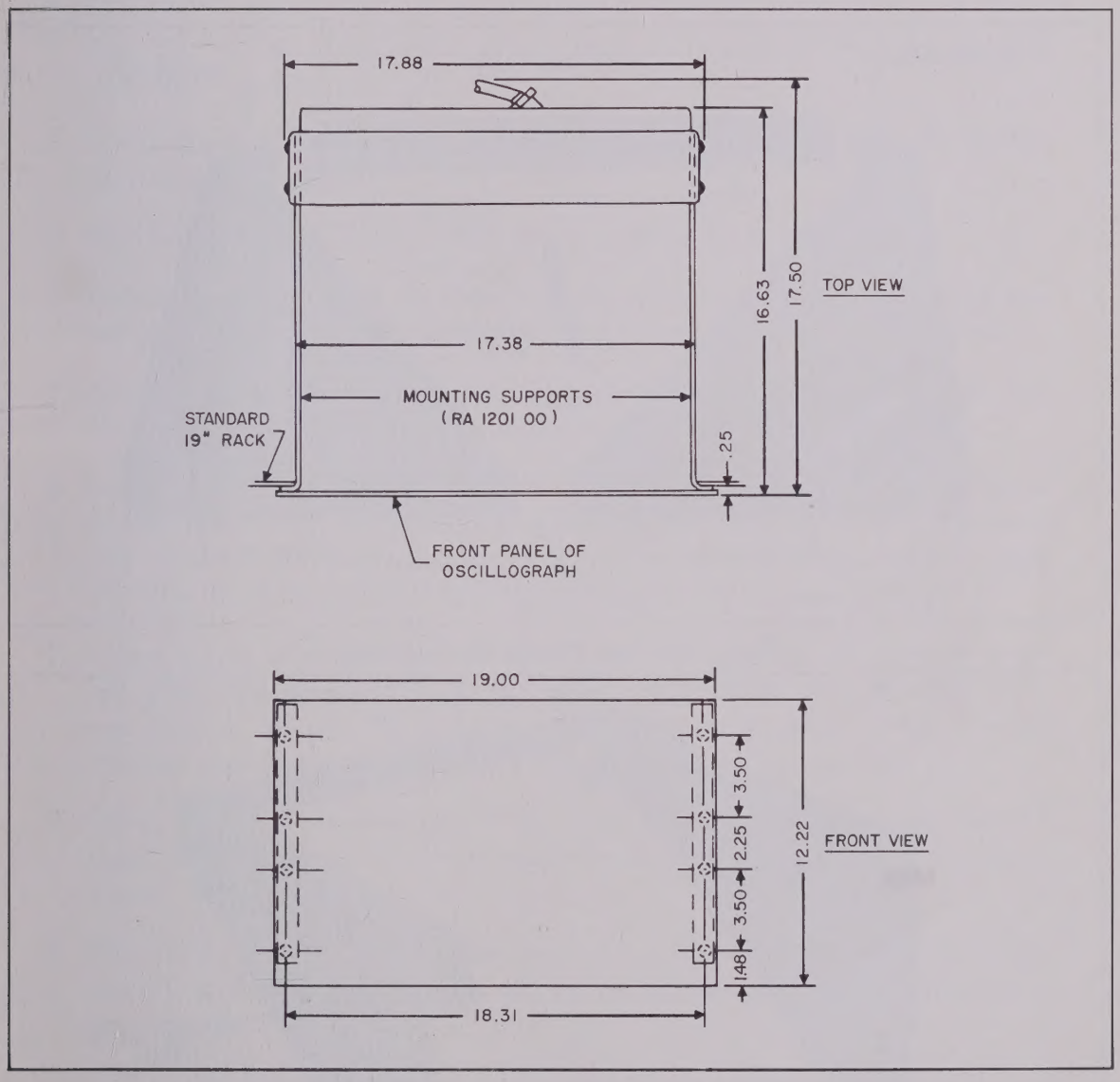
SPECIFICATIONS

The following specifications are applicable to the oscillographs when properly matched with Brush amplifiers, whether used for ink writing with ink pens, Model RA 2821 30, or for electric writing with electric styli, Model RA 2822 30.

Specifications for sensitivity, linearity, frequency response, and amplitude represent the basic performance of the Brush penmotor. They are stated in terms of the 40 mm wide, 40 line chart, used with the six channel oscillograph.

D.C. Sensitivity	Approximately 30 volts will produce a deflection of 20 mm from chart center (full scale); 1.5 volts per mm; 1.1 ma per mm.
Channel Width	
6 Channel	40 mm (40 divisions).
8 Channel	36 mm (40 divisions).
Measured Trace Linearity	d.c.—within 1% of full chart width; a.c.—within 2% of full chart width, any frequency up to 100 cps for ink writing. Deviations are measured from a line through the point of maximum deflection on the chart and through the point of zero voltage and zero deflection.
Frequency Response	Recorded peak to peak amplitude of a constant voltage sine wave will be within ±½ chart line (mm) of nominal 40 lines from d.c. to 10 cps or within ±1 chart line (mm) of a nominal 10 lines from d.c. to 100 cps.
Maximum Amplitude	40 lines (mm) peak to peak, to 40 cps. 20 lines (mm) peak to peak, to 70 cps. 10 lines (mm) peak to peak, to 100 cps.
Chart Speeds	
Standard	1, 2, 5, 10, 25, 50, 125, and 250 mm per second.
Accessory Slow Speed Drive	1, 2, 5, 10, 25, 50, 125, and 250 cm per hour. Chart speeds may be instantaneously selected by turning a switch on the panel or at remote locations.
Operating Temperature Range	32° F to 135° F (electric writing). 32° F to 135° F (low temperature ink).
Trace Width	
Ink Writing	0.015 inch with Pen, Model RA 2821 30. Note: Special fine line pen available with trace width of 0.010 inch.
Electric Writing	0.005 inch with Stylus, Model RA 2822 30.
Chart Speed Regulation	Synchronous motor, direct drive.
Paper Drift	Less than ±1/3 mm.
Power Requirements	105 - 125v, 60 cps, 135 watts at 115v.
Dimensions	Standard 19″ panel, 12¼″ high, 17½″ deep—including connectors.
Weight	Six channels, 79 pounds—8 channels, 89 pounds.
Shipping Weight	Six channels, 85 pounds—8 channels, 95 pounds. A separate carton containing Junction Box, cables, etc., accompanies each oscillograph — shipping weight, 20 pounds.

DIMENSIONAL OUTLINE



INSTALLING OSCILLOGRAPH IN RACK OR CONSOLE CABINET

These oscillographs may be installed in a standard 19″ rack or Console Cabinet, Model RA 1112 61, for table-top applications.

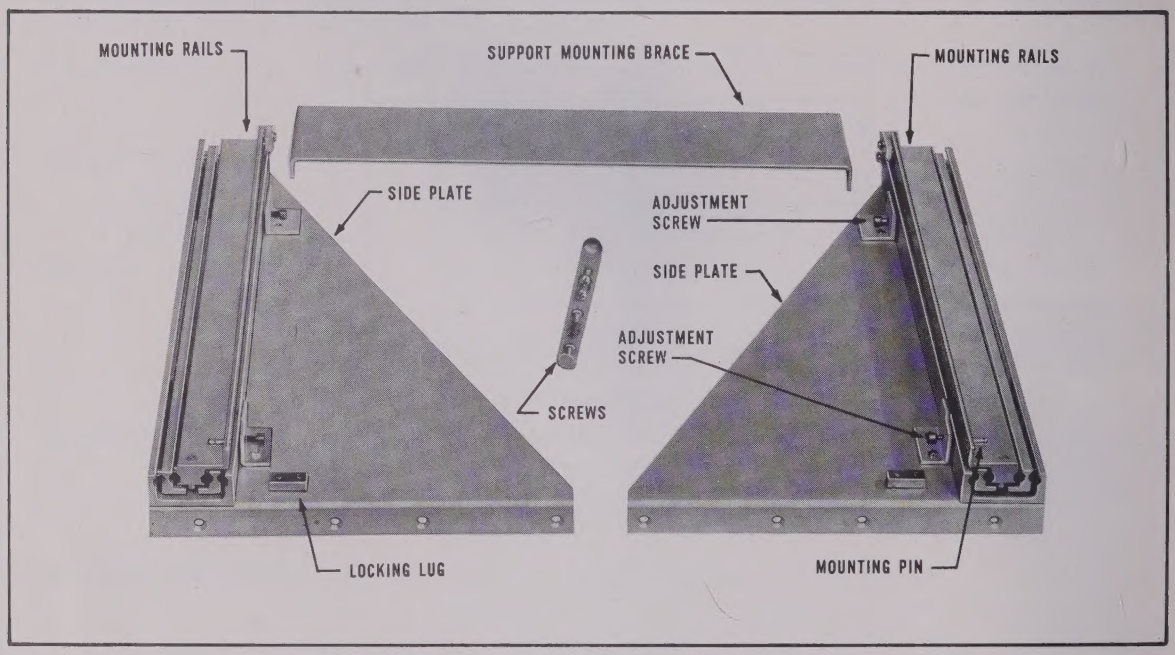


Fig. 1. Brush Rack Mounting Kit, Unassembled.

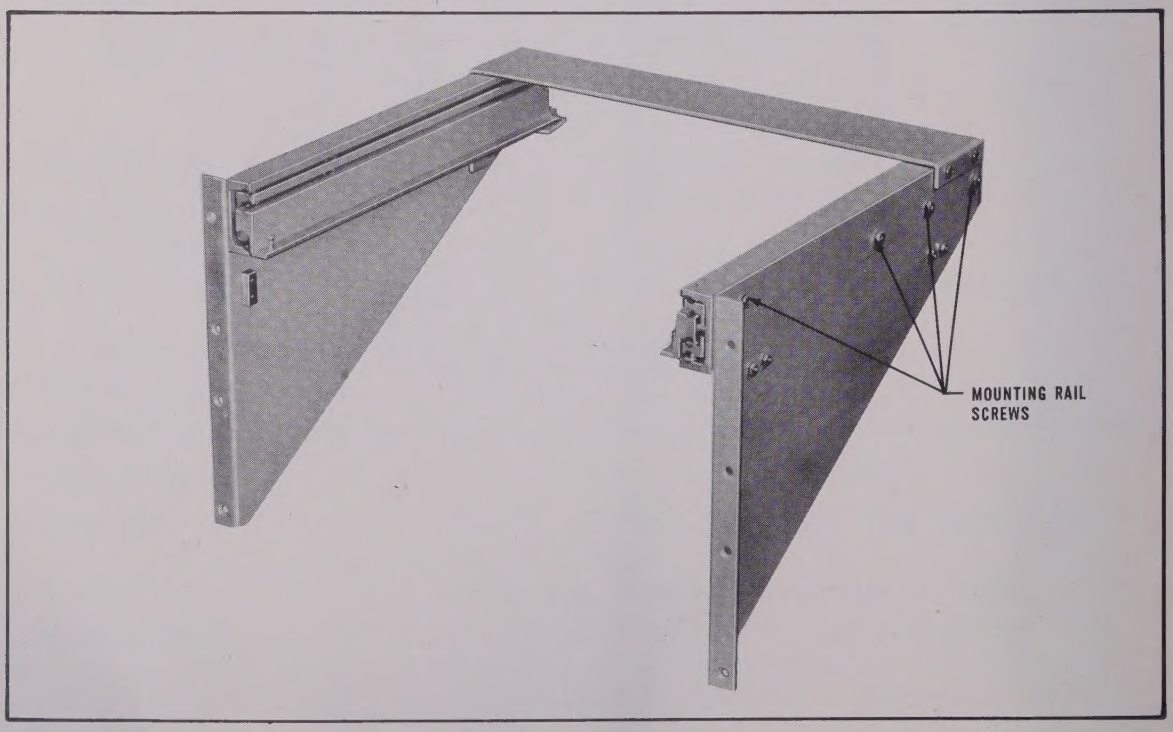


Fig. 2. Brush Rack Mounting Kit, Assembled.

RACK MOUNTING

The Brush Rack Mounting Kit Model RA 1201 00 is available for mounting the oscillograph in a standard 19″ rack (Fig. 1). To mount the oscillograph in a standard rack, proceed as follows:

1. Assemble the Rack Mounting Kit, securing the support mounting brace to the side plates with four screws (Fig. 2).

2. Position the Rack Mounting Kit in the rack, and secure side plates to rack rails with four flat head screws (supplied).

3. Withdraw slides until they are locked in position by latches at rear of slides.

4. Position the oscillograph on the slides, engaging the small mounting hole on each side rail of the oscillograph with the corresponding mounting pin on the mounting rail.

5. Release latches on the rear of the slides, and move the oscillograph into the rack; lock the oscillograph in position with two latches on the front panel.

6. Check alignment of the oscillograph front panel with the rack and with front panels of other equipment in the rack. If the oscillograph front panel is not aligned properly with the rack or associated equipment, unlock the latches on the oscillograph front panel, withdraw the oscillograph to "servicing" position, and remove from the slides.

7. Loosen, but do not remove the rear three of the four mounting rail screws on either side plate. (The fourth screw can be reached only when the Rack Mounting Kit is removed from the rack. The mounting rail can ordinarily be moved enough to correct improper alignment if the three screws at the rear of the rail are loosened.)

8. Change position of mounting rails on side plates as required for proper alignment, by means of the adjustment screws, and tighten the mounting rail screws loosened in step 7, above.

9. Position the oscillograph on the slides and return to "operating" position. Check alignment of the oscillograph front panel with the rack and associated equipment. If necessary, repeat steps 6, 7, and 8, above.

If the oscillograph is mounted in any rack other than the Brush Rack Model RA 1152 60, take any steps necessary to prevent the rack from toppling during installation of chart paper or other servicing operations.

CONSOLE CABINET MOUNTING

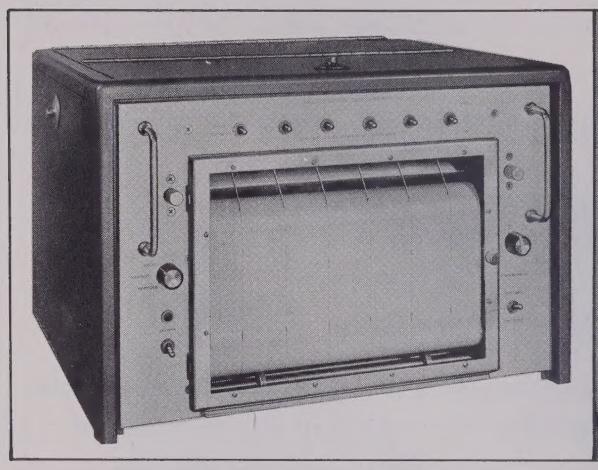


Fig. 3. Multi-Channel Oscillograph mounted in Console Cabinet, Model RA 1112 61.

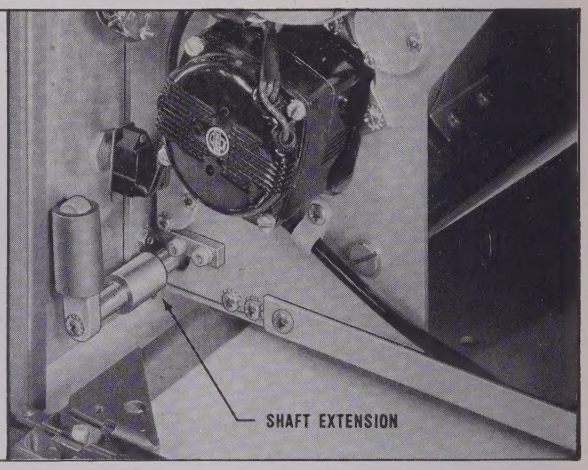


Fig. 4. Oscillograph, right side view, showing pressure roller release shaft extension. Lever shown in operating position.

The Console Cabinet Model RA 1112 61 has been designed to permit bench-top operation of Brush Multi-Channel Oscillographs. Included with the cabinet are mounting screws, clamping plates, bottom reinforcement bars, eight ink traps, and a pressure roller release shaft extension.

To mount an oscillograph in the Console Cabinet, proceed as follows:

1. Remove the PRESSURE ROLLER RELEASE LEVER, on the right side of the oscillograph and mount the pressure roller release shaft extension. Fig. 4. Then mount the PRESSURE ROLLER RELEASE LEVER on the end of the pressure roller release shaft extension. To release pressure on the PRESSURE ROLLERS, move the PRESSURE ROLLER RELEASE LEVER to a vertical position. The shaft extension now permits the PRESSURE ROLLER RELEASE LEVER to clear other components of the oscillograph when moved to the vertical position. Fig. 4.
2. The oscillograph is secured within the Console Cabinet by four socket-head screws, two bottom re-enforcement bars at the base of the unit, and two corner clamping plates secured behind the front panel and held in place by the upper screws in the PULL-OUT HANDLES. Extra long screws are furnished for this purpose. When these screws are tightened, the clamping plates may be expected to bend slightly while conforming.
3. Eight formed tubes are supplied with the console mounting accessories. These tubes act as ink traps in case the oscillograph should be carried in a vertical position. The ink traps are inserted in the inkwell corks so that the bent portion will extend toward the front panel.

Once mounted within the console, complete access to the oscillograph is provided through hinged panels on either side and on the top to permit routine servicing (replacing chart paper, replenishing ink, etc.).

PREPARATION FOR USE

The Six Channel Combination Oscillograph, Model RD 2662 00, has been used throughout these Operating Procedures for illustration purposes. Nevertheless, they are equally applicable to the Eight Channel Combination Oscillograph, Model RD 2682 00, and by disregarding any information concerning electric writing, they apply to the Six Channel Oscillograph (ink only), Model RD 2661 00. All oscillographs are shipped from the factory with ink pens and inkwells mounted.

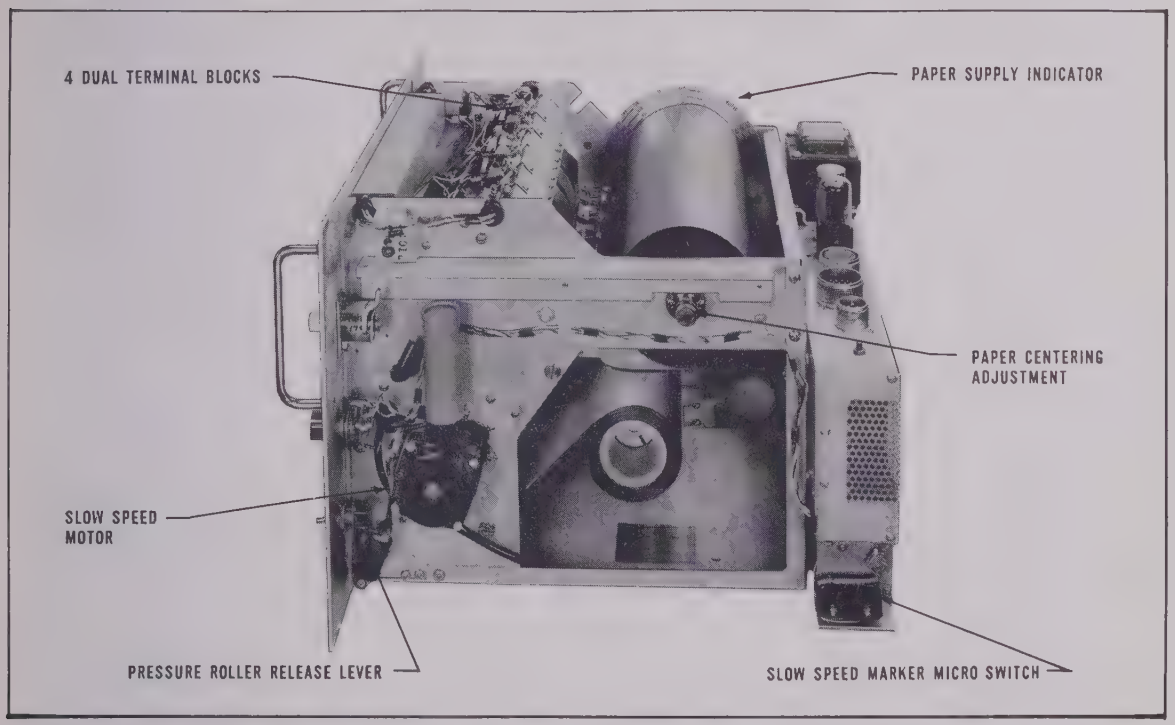


Fig. 5. Right Side of Six Channel Combination Oscillograph, Model RD 2662 00, Unmounted.

TO FILL INKWELLS

To fill inkwells proceed as follows:

1. Remove the rubber stopper and by means of a medicine dropper (or the dropper supplied with the 2 oz. bottle of Brush ink) fill the inkwell.
2. Replace the stopper.
3. To start the ink flowing, empty the medicine dropper and insert it tightly in the small breather hole at the top of the stopper. Press a few times on the bulb until the ink begins to flow. The dropper must be held tightly in the stopper to prevent the ink from squirting. Remove and later replace formed tube in cork, if any.
4. The ink will continue to flow by capillary action. Always keep the pen on the chart paper when not in use as this prevents the ink from drying in the PEN TIP.

It is recommended that both PEN and INKWELL be removed and thoroughly cleaned, if the oscillograph remains unused for more than three days. It is important to clean the INKWELL because of possible accumulation of residue in the bottom of the INKWELL which, if allowed to remain, may break free and possibly clog the PEN. Even though in constant use, it is well to clean the INKWELL occasionally for the same reason. For instructions on cleaning PENS and INKWELLS, refer to Section VI—Maintenance.

TO LOAD OR CHANGE CHART PAPER

To load or change chart paper, proceed as follows:

1. Cut the end of the chart paper at approximately a 45° angle with the point in the direction of channel 6.
2. Loosen (but do not remove) the PAPER CENTERING ADJUSTMENT until the chart paper supply shaft can be removed from the oscillograph. Fig. 5.
3. Tamp the end of the paper supply on a flat surface so that the roll will fit snugly and evenly against the face of the PAPER SUPPLY INDICATOR. Fig. 5.
4. Place the paper supply on the chart paper supply shaft, using care to have the paper fit snugly and evenly against the PAPER SUPPLY INDICATOR. If necessary, tamp that end of the paper supply shaft on a hard surface.
5. Replace the paper supply shaft and the paper supply in the oscillograph.
6. Tighten the PAPER CENTERING ADJUSTMENT until the chart paper supply shaft is displaced approximately ¼" from the right side plate of the oscillograph.
7. Lift the pens or styli by means of the penlifter. This is to avoid possible damage to the tips of the pens or styli.

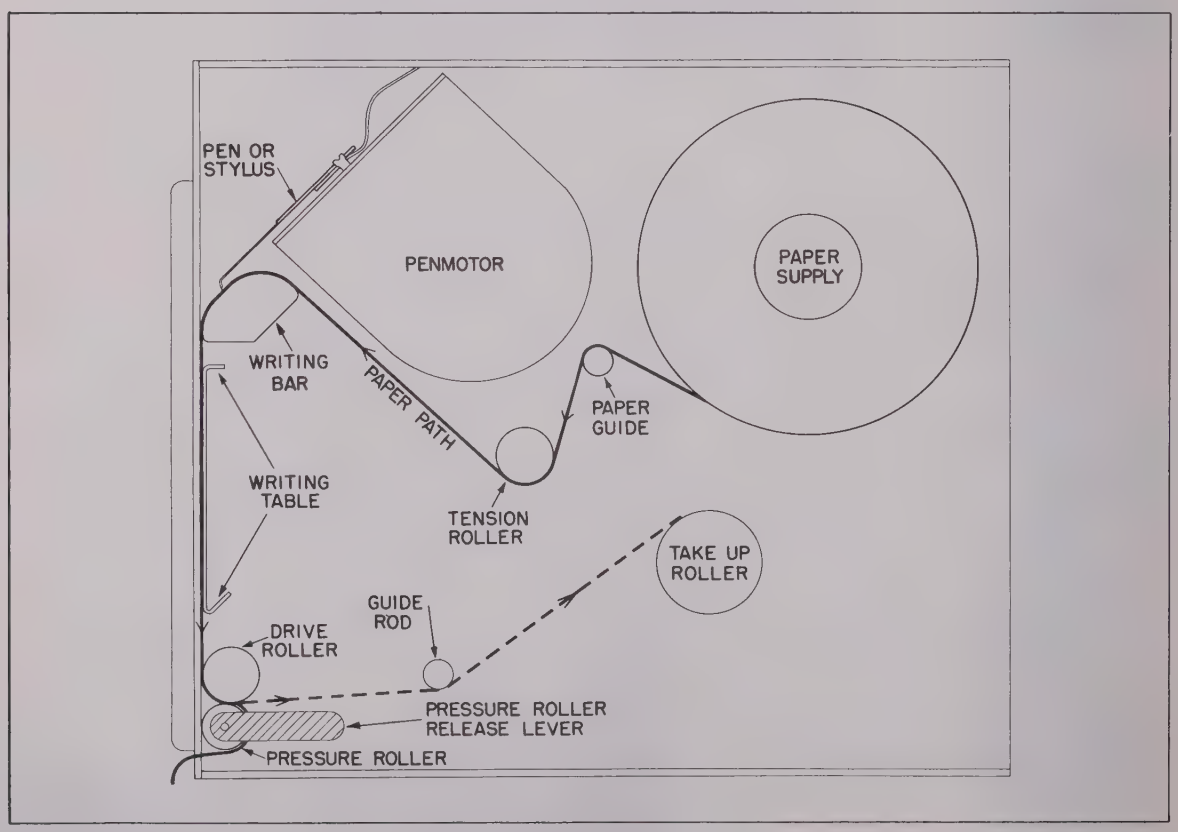


Fig. 6. Diagram of Paper Supply.

8. Thread the paper over the PAPER GUIDE; under the TENSION ROLLER; over the WRITING BAR; down and over the WRITING TABLE. Fig. 6.
9. Release the PRESSURE ROLLER by means of the PRESSURE ROLLER RELEASE LEVER. Fig. 6.
10. Thread the paper between the DRIVE ROLLER and the PRESSURE ROLLER; down through the paper chute; and out the front of the oscillograph as indicated in Fig. 6.
11. Restore the pressure on the DRIVE ROLLER by means of the PRESSURE ROLLER RELEASE LEVER.
12. Lower the pens or styli by means of the penlifter.

INTERNAL REWIND

When recordings are to be made on relatively long strips of chart paper and saved for future study, the chart paper may be rewound inside the instrument on the take-up roller. To set up the instrument for internal rewind operation, follow the procedures described under "To Load or Change Chart Paper," above (allowing at least 9 inches of chart paper to issue from the front of the oscillograph), and proceed as follows:

1. Withdraw the oscillograph to "servicing" position, slide an empty paper core (supplied) as far as possible on the TAKE-UP ROLLER, then withdraw the core approximately ⅛". The small knife-edged wheels cut into the core to prevent slipping.
2. Place a small strip of self-adhering cellophane tape at each side of the chart paper to fasten the paper temporarily to the WRITING BAR. Cut off the chart paper 9 inches from the bottom of the paper chute, then cut the corners at the end of the chart paper to form a "V" at the center of the paper.
3. Release the PRESSURE ROLLERS from the DRIVE ROLLER by means of the PRESSURE ROLLER RELEASE LEVER, and withdraw the chart paper from the rollers. Thread the chart paper between the DRIVE ROLLER and the PRESSURE ROLLERS, under the GUIDE ROD, and to the top of the paper core on the TAKE-UP ROLLER, as indicated by the dotted line (Fig. 6).
4. Fasten a short strip of self-adhering cellophane tape to the "V" end of the chart paper, with a short length extending beyond the paper. Center the chart paper on the TAKE-UP ROLLER with one hand; with the other hand, test paper tension at each end of the TAKE-UP ROLLER, the GUIDE ROD, and the WRITING TABLE. Move the chart paper to the right or left side of the TAKE-UP ROLLER as required to produce equal tension at the ends of the TAKE-UP ROLLER; then fasten the chart paper to the empty paper core on the TAKE-UP ROLLER with the cellophane tape. Apply the PRESSURE ROLLERS to the DRIVE ROLLER with the PRESSURE ROLLER RELEASE LEVER. Remove the cellophane tape securing the chart paper to the WRITING BAR.
5. Operate the oscillograph at medium chart speed until one full turn of paper is rewound on the paper core. If the beginning of the second turn of paper is not aligned with the first turn, slide the paper core in or out, as necessary to correct the alignment of chart paper on the core.
6. When the chart paper is aligned properly on the TAKE-UP ROLLER, slide the oscillograph into place in the rack and secure the front panel latches.

TO REMOVE STYLI OR PENS AND INKWELLS

If it is desired to write with electric styli on Teledeltos chart paper, it will be necessary to remove the PENS and INKWELLS and replace them with electric styli. This applies to the Eight Channel Combination Oscillograph, Model RD 2682 00, and the Six Channel Combination Oscillograph, Model RD 2662 00, only. To make this change proceed as follows:

1. Spread the sides of the PENHOLDER (Fig. 7.) with the tips of the Pen Mounting Tool (supplied).
2. Slide the PEN from the PENHOLDER. Avoid snagging the PEN TIP while removing it. Fig. 7.
3. While holding the PEN, remove the INKWELL from its holder.
4. Over an expendable surface (old newspapers, etc.) remove the CAPILLARY TUBE from the INKWELL. Do *not* remove the CAPILLARY TUBE from the PEN.
5. Clean both PENS and INKWELLS before storing, to prevent the ink from drying in them. For instructions on cleaning PENS and INKWELLS, refer to Section VI. Maintenance.
6. After removing pens, store each one in a separate container (tube, envelope, etc.) identified by number (1, 2, 3, etc.) with the penmotor from which it was removed. This eliminates re-lapping the pens after remounting.
7. Remove electric styli in a similar manner to ink pens.

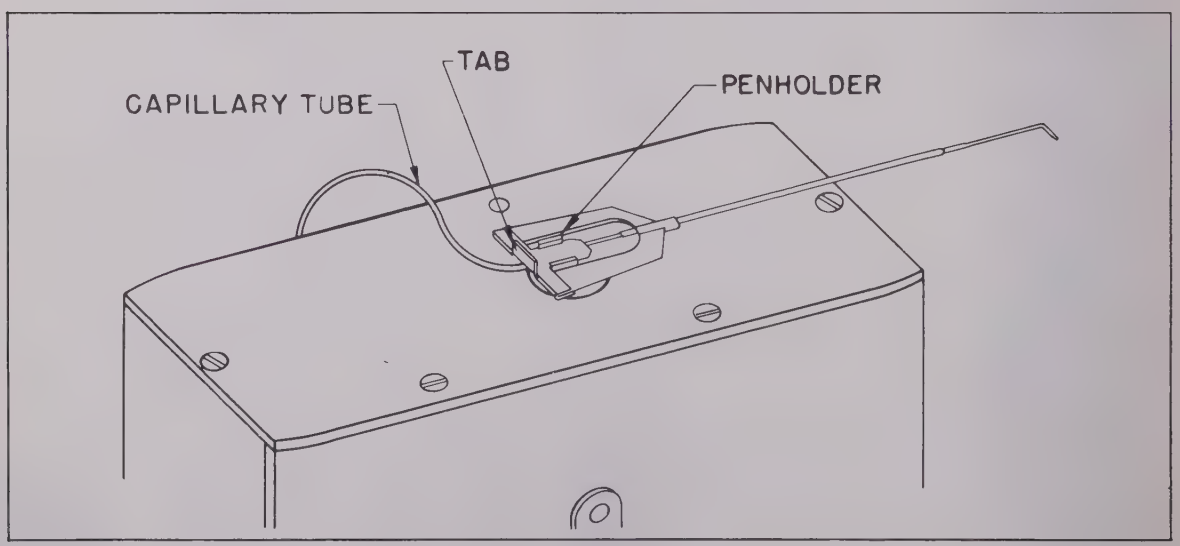


Fig. 7. Diagram of Penmotor.

TO MOUNT PENS

To mount pens proceed as follows:

1. Grasp the SHANK of the PEN between the thumb and forefinger. Fig. 8.
2. Place the YOKE of the PEN over the PENHOLDER in such a manner that the PENHOLDER will protrude through the YOKE of the PEN. In this position, the TONGUE of the PEN is behind the PENHOLDER.
3. Align the TONGUE of the PEN with the grooves of the PENHOLDER. Figs. 7 and 8.
4. Gently spread the sides of the PENHOLDER by means of the Pen Mounting Tool (supplied).
5. With the sides of the PENHOLDER spread, insert the PEN as far as possible. It is important that the PEN be well seated.
6. After removing the Pen Mounting Tool, examine the PEN in the PENHOLDER to determine that the TONGUE is secure and is held in the bottom of the grooves of the PENHOLDER.
7. Lead the CAPILLARY TUBE of the ink PEN to the left of the PENMOTOR.
8. Slip the CAPILLARY TUBE over the metal tube of the INKWELL.
9. Mount the INKWELL in its holder.

TO MOUNT STYLI

To mount electric styli, proceed as follows:

1. Repeat steps 1 through 6, above.
2. Plug the lead from the stylus into one side of the DUAL TERMINAL BLOCK above and between adjacent PENMOTORS. Fig. 5. The extreme left and right terminals of the extreme left and right DUAL TERMINAL BLOCKS are to be used exclusive for the LEFT and RIGHT EVENT MARKERS stylus leads.

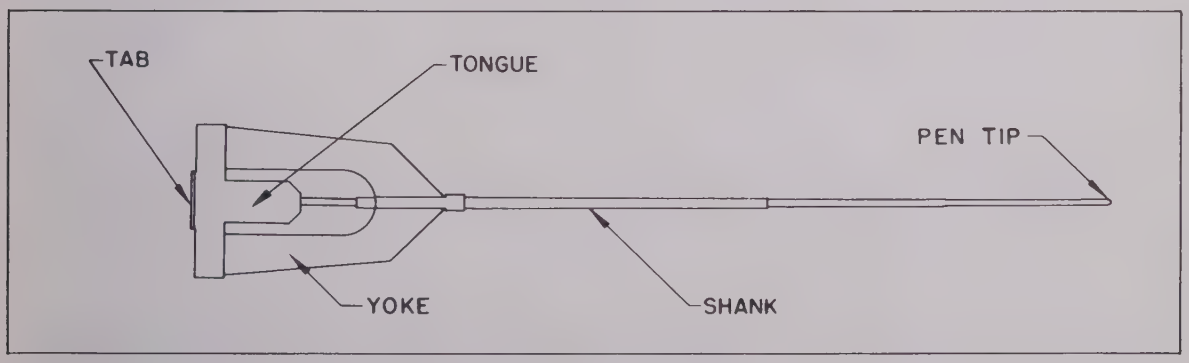


Fig. 8. Diagram of PEN.

TO ADJUST PEN OR STYLUS PRESSURE

When new pens or styli are installed, it is important that the tips of the pens or styli apply .5 to .75 gram pressure on the chart paper. This measurement is critical and must be made very accurately. The reading is taken with the hook of the Gram Gage (Brush Part No. 227418-910) under the PEN or stylus at a point 1/32" back of the tip, immediately at the time the tip is lifted from the chart paper. For complete pen pressure information, refer to Section V—Theory of Operation. If the pen or stylus pressure is unsatisfactory, adjust it as follows:

1. If the pressure is too *great,* it may be reduced by lifting the PEN tip (while it is in the PENHOLDER) a few times until the proper pressure is achieved. In electric writing, be sure the current is turned "off" as the styli carry a high voltage.
2. If the pressure is too *little,* the PEN must be removed from the PENHOLDER before the pressure can be increased.
3. After removing the PEN from the PENHOLDER, grasp the TONGUE-TAB in one hand and the YOKE in the other.
4. Bend the center of the YOKE upward. This changes the plane of the TONGUE in relation to the plane of the YOKE and produces more pressure on the chart paper when the PEN is remounted.
5. Remount the PEN in its PENHOLDER.
6. Re-measure the PEN pressure. It may be necessary to repeat the above steps.

TO ALIGN PENS OR STYLI

To align pen tips:

1. Be sure all PENS are seated in the PENHOLDERS as far as possible.
2. If necessary, the pens can be backed-out of the PENHOLDER a slight distance by the use of the Pen Mounting Tool supplied with the instrument. Insert the tips of the Pen Mounting Tool in the PENHOLDER. By gently squeezing the Pen Mounting Tool, the sides of the PENHOLDER can be expanded enough to permit backing-out of the PEN TIP so that it will be aligned with the other PEN TIPS. The shortest PEN should always be seated as far as possible in the PENHOLDER.

   NOTE: The above information applies equally well to the styli in electric writing.

TO LAP PENS

When replacing ink pens, it is necessary to lap the pens after installation, in order to write uniformily at all frequencies and at all chart paper speeds. To do this, connect the oscillograph to an appropriate power source and to an amplifier and an oscillator, as described in the Operating Instructions for the particular amplifier being used, then proceed as follows:

1. Release the tension on the PRESSURE ROLLERS. Fig. 9. This is to keep the chart paper from moving.
2. Lap the pen tip by operating the oscillograph at approximately 60 cps, with the strip of abrasive (supplied with the pen) under the pen tip. Allow ink to flow through the PEN to lubricate the pen tip during the lapping process.
3. Restore tension on the PRESSURE ROLLERS and test for satisfactory pen trace at various frequencies and at all chart paper speeds. Repeat lapping, if necessary.

It is recommended that both the PEN and INKWELL be removed and thoroughly cleaned if the oscillograph remains unused for more than three days. It is important to clean the INKWELL because of possible accumulation of sediment in the bottom of the INKWELL, which if allowed to remain may possibly clog the PEN. Even though in constant use, it is well to clean the INKWELL occasionally for the same reason. For instructions on cleaning PENS and INKWELLS, refer to Section VI—Maintenance.

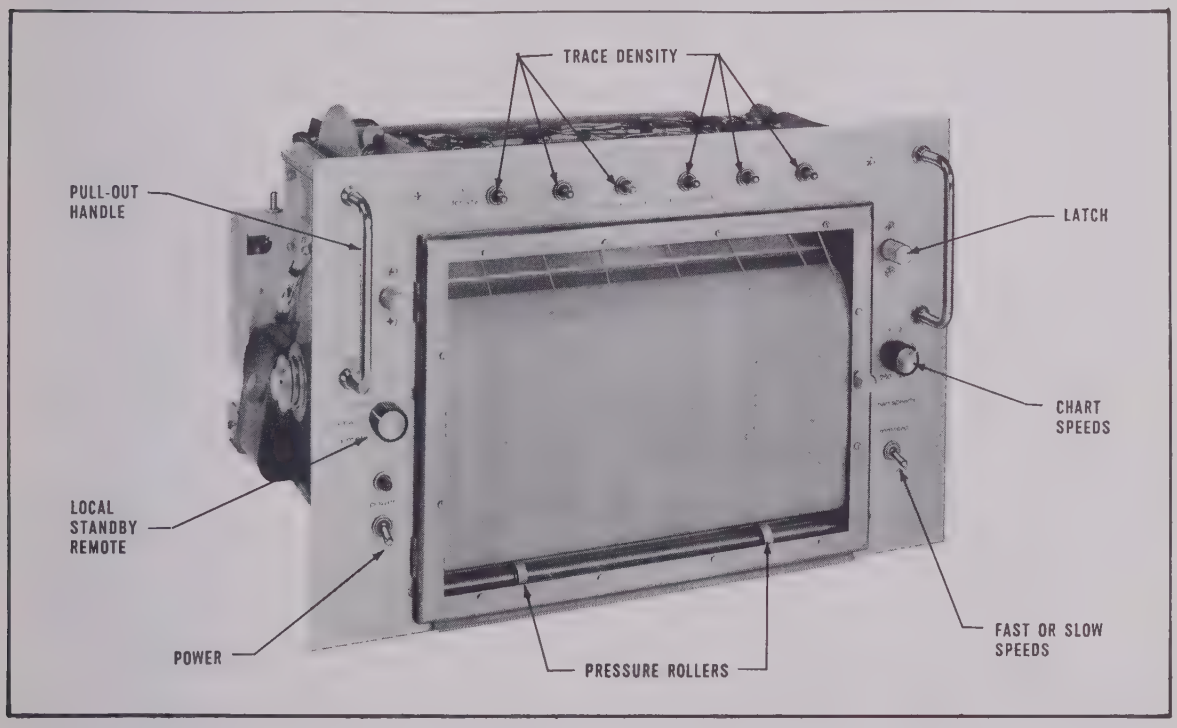


Fig. 9. Front View of Six Channel Oscillograph, Model RD 2662 00, Unmounted.

PRELIMINARY OPERATION

TO SET UP THE INSTRUMENT

Set up and test the instrument in the following manner:

1. Connect the oscillograph to an appropriate power source (105-125v, 60 cps).
2. Turn the LOCAL - STANDBY - REMOTE switch to "STANDBY".
3. Turn the POWER switch to "on". In electric writing, allow 2 to 3 minutes warm up time.
4. Turn the CHART SPEEDS switch to "25", Twenty-five millimeters per second is fast enough to align chart paper and slow enough to conserve chart paper.
5. Turn the LOCAL - STANDBY - REMOTE switch to "LOCAL".
6. Examine the pen or stylus traces. They must all be on the center line of the respective channels of the chart paper to within .015 inch (3/8 of 1 mm). If they are uniformly off, tighten or loosen the PAPER CENTERING ADJUSTMENT as may be indicated, until the pens or styli do trace on the center line.
7. Turn the POWER switch "off".

8. After properly centering the chart paper, lock the PAPER CENTERING ADJUSTMENT semi-permanently by means of knurled lock nut on the PAPER CENTERING ADJUSTMENT. Fig. 5. Upon subsequent loading of the oscillograph with a new supply of chart paper, this lock nut establishes the position of the PAPER CENTERING ADJUSTMENT.
9. Connect each channel of the oscillograph to a Brush amplifier; turn "on" and warm up amplifiers.
10. Adjust each channel for frequency compensation as explained in the Operating Instructions for the particular Brush amplifiers being used.
11. Observe writing characteristics during the above step. Adjust pen or stylus pressures, if necessary.
12. Turn "off" the oscillograph, amplifiers, and oscillator.

TO CONNECT EVENT MARKERS

The left Event Marker operates in a dual capacity, either to place an event mark on the chart paper by means of a customer supplied, normally open switch, or to place a time pulse on the chart paper. The customer supplied switch must be connected to pin "G" and to pin "T" (ground) of the REMOTE CONTROL INPUT connector (J-3) on the rear panel of the oscillograph. Fig. 10. The EVENT MARKER SWITCH (toggle) on the rear of the oscillograph must be in the position marked "EXT" (external) if it is to be used with a customer supplied switch. This switch in position marked "TIMER" works in conjunction with the accessory Slow and Fast Timer Motors.

The right Event Marker operates exclusively by means of a customer supplied, normally open switch. This switch must be connected to pin "F" and to pin "T" (ground) of the REMOTE CONTROL INPUT connector (J-3) on the rear of the oscillograph. Fig. 10.

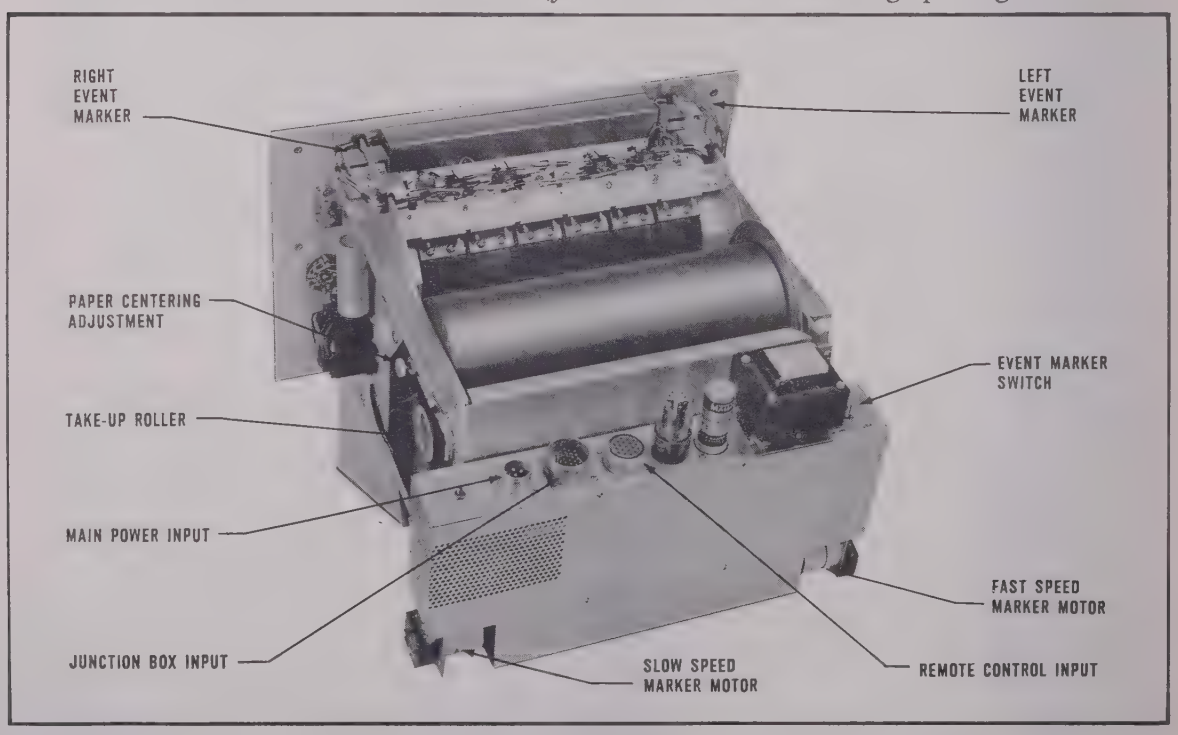


Fig. 10. Rear and Top View of Six Channel Oscillograph, Model 2662 00, Unmounted.

TO CONNECT REMOTE CONTROL

To operate the oscillograph from a remote position, proceed as follows:

1. Load the instrument with the proper chart paper; mount and adjust the ink pens or electric styli; mount and fill ink wells or connect the leads of the electric styli to the terminal blocks; and test the oscillograph as explained under Section III. Operating Procedure.
2. Turn the POWER switch of the oscillograph to "off". Fig. 9.
3. Turn the LOCAL - STANDBY - REMOTE switch of the oscillograph to "STANDBY".
4. Connect the Remote Control Unit (either the standard 19″ panel for rack mounting or the console model) to the rear of the oscillograph at the REMOTE CONTROL INPUT connector as shown in Fig. 10, by means of the twenty-five foot cable supplied with the unit. Longer cables are available on special order.
5. In the case of electric writing, turn the TRACE DENSITY switches to either "high" or "low". This selection is at the option of the operator. The density of the trace for each individual channel is a function of and determined by the frequency and amplitude of the recorded signal and the chart paper speed.
6. Turn the STANDBY - RECORD switch of the Remote Control Unit to "STANDBY".
7. Turn the MM/SEC - CM/HR switch of the Remote Control Unit to the desired setting.
8. Turn the rotary CHART SPEED switch of the Remote Control Unit to the desired chart paper speed. This switch operates in conjunction with the MM/SEC - CM/HR switch of the Remote Control Unit.
9. Connect the amplifiers to the oscillograph as in local operation.
10. Connect the main power input cable to an appropriate power source (105-125v, 60 cps) and to the rear of the oscillograph at the 3-pin AN connector.

The instrument is now set up for remote operation. To operate the oscillograph, proceed as follows:

1. Turn the POWER switch of the oscillograph to "on". In the case of electric writing, allow a few minutes warm-up time.
2. Turn the LOCAL - STANDBY - REMOTE switch of the oscillograph to "REMOTE".
3. Turn the STANDBY - RECORD switch of the Remote Control Unit to "RECORD". This starts the oscillograph and is the operational on-off switch.

OPERATION

Brush oscillographs are designed to operate in connection with Brush amplifiers. Frequency compensation of each amplifier may be adjusted to match the penmotor with which it is used. For frequency compensation procedure, refer to the appropriate amplifier Operating Instructions. The circuitry of the amplifier prevents more than 100 volts a.c. (peak to peak) being applied to the penmotors of the oscillographs. If amplifiers other than Brush amplifiers are used, precautionary measures must be employed to prevent more than this voltage being applied to the penmotors. The performance of Brush oscillographs cannot be guaranteed if matched with amplifiers other than Brush amplifiers.

OPERATING SUPPLIES

DESCRIPTION	BRUSH PART NO
Chart Paper—Ink—6 Channel—840′ long	RA 2961 80
Chart Paper—Ink—8 Channel—840′ long	RA 2981 90
Chart Paper—Electric—6 Channel—500′ long	RA 2962 50
Chart Paper—Electric—8 Channel—500′ long	RA 2982 51
Red Ink (Standard)—Available in 2 oz., 1 pt., and 1 qt. containers. Ink is available in other colors on special order.	

ACCESSORIES

SLOW SPEED MOTOR KIT—Model RA 2102 20

The Slow Speed Motor Kit is a synchronous motor, mounted within the chassis of Oscillographs, Models RD 2682 00, RD 2662 00 and RD 2661 00. The motor is factory installed when purchased with either oscillograph, but may be purchased and installed at a later date, if desired. The Slow Speed Motor is used for special applications where recordings over a long period of time are to be made. This motor, mounted inside the chassis, drives through the standard motor by means of an over-running spring type clutch and provides chart paper speeds of 1, 2, 5, 10, 25, 50, 125, and 250 centimeters per hour in addition to the standard speeds in millimeters per second.

EVENT MARKER—LEFT—Model RA 2103 21

The accessory Left Event Marker operates in a dual capacity, either to place an event mark on the chart paper by means of a customer supplied shorting switch or to place a time pulse on the chart paper. The oscillograph is pre-wired to supply 90v, d.c. for this purpose. In the latter case, it operates in connection with the accessory Fast and Slow Marker Motors. An EVENT MARKER SWITCH (double pole, double throw, center off) is located near the power transformer on the rear of the oscillograph. Fig. 10. One position marked "EXT" (external) provides for the connection to the customer supplied, normally open, shorting switch. The other position marked "TIMER" places an accurate time pulse on the left edge of the chart paper. This position works in conjunction with the FAST OR SLOW SPEEDS switch on the front of the oscillograph. Fig. 9. With the EVENT MARKER SWITCH in the "TIMER" position and the FAST or SLOW SPEEDS switch in the fast or "mm/sec" position, a one second pulse mark is placed inward toward the center of the chart paper. This one second pulse requires an accessory FAST SPEED MARKER MOTOR. Fig. 12.

With the EVENT MARKER SWITCH in the "TIMER" position and the FAST OR SLOW SPEEDS switch in the slow or "cm/hour" position, a six minute pulse mark is placed outward from the center of the chart paper. This six minute pulse requires an accessory SLOW SPEED MOTOR as well as an accessory SLOW SPEED MARKER MOTOR. Fig. 10.

Event Markers for Model RD 2682 00 Oscillograph are available on special order.

EVENT MARKER—RIGHT—Model RA 2103 22

The accessory Right Event Marker functions only when actuated by means of a customer supplied, normally open switch. The oscillograph is pre-wired to supply 90v, d.c. for this purpose. Both of the above Event Markers are available in kit form for field installation. Complete Installation Instructions accompany each kit.

Event Markers for Model RD 2682 00 Oscillograph are available on special order.

FAST AND SLOW MARKER MOTORS—Model RA 2101 10 (fast)—Model RA 2101 20 (slow)

The FAST and SLOW MARKER MOTORS actuate micro-switches designed to open and close the LEFT EVENT MARKER coil circuit, so that time correlation of the recorded phenomena may be obtained. The FAST MARKER MOTOR operates in connection with the standard motor drive and places a pulse mark on the chart paper at one second intervals. The SLOW SPEED MARKER MOTOR operates in connection with the accessory SLOW SPEED MOTOR (Fig. 5) and places a pulse mark on the chart paper at six minute intervals. For a complete explanation of the pulse marks refer to "Event Markers—Left". Both of the above Marker Motors are available in kit form for field installation. Complete Installation Instructions accompany each kit.

REMOTE CONTROL BOX—Model RA 2403 03

The Remote Control Box functions similarly to the Remote Control Panel but is designed for console or table-top applications.

REMOTE CONTROL PANEL—Model RA 2403 04

A standard 19″ panel (3½″ wide) for rack mounting provides a means of starting and stopping the oscillograph as well as changing chart paper speeds at a position remote from the oscillograph.

THE PENMOTOR

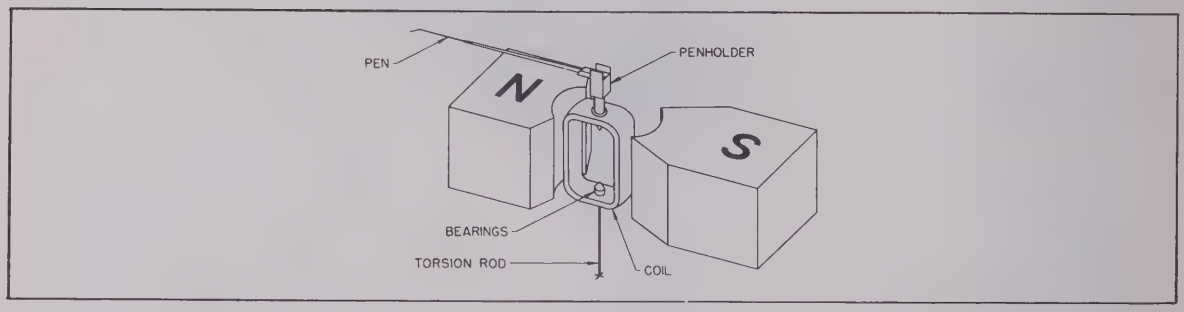


Fig. 11. Simplified Drawing of Penmotor.

The Brush Magnetic Penmotor makes use of the familiar D'Arsonval galvanometer type mechanism in which the coil is used to deflect a pen instead of the conventional mirror.

The penmotor, Figure 11, consists of a coil supported by sapphire jewelled bearings and mounted in the magnetic field of an Alnico V structure. A signal current passing through the coil causes, by motor action, a deflection of the coil about its axis; the deflection in turn causes the movement of the writing pen which is affixed to the coil.

The Brush penmotor differs from the classical galvanometer with its delicate hair springs, in that it makes use of a heavy torsion spring which maintains the zero position of the coil, and also serves the function of holding the coil in its upper bearing by supplying a downward force.

The resonant frequency of the penmotor is established by the stiffness of the torsion spring and the mass of the combined coil and pen assembly. In the subject penmotor the resonance is at a relatively high frequency (about 47 cycles) and the system has the necessary stiffness to maintain a high degree of linearity in the presence of the variable effects of pen tip friction on the writing medium.

The flatness of frequency response with constant voltage input is determined by a number of factors which must be in the proper relationship to obtain the required damping. The mass of the moving system, the stiffness of the torsion spring, the magnetic flux, and the relationship of coil turns and resistance must all be carefully related in the penmotor design to obtain critical damping.

A penmotor so constructed will have a frequency response which is flat to 60 per cent of its resonant frequency when properly matched to its driving source. The Brush penmotor yields a response which is flat to about 30 cycles.

The penmotors, when driven by the Brush RD series amplifiers operate at about 60 per cent of critical damping which provides the optimum balance between transient response and frequency response. The Brush RD series amplifiers, in addition to providing optimum damping characteristics, include compensating networks to off-set the decreasing sensitivity of the penmotor above its natural frequency. The compensation adjustment thus can provide a flat response from D.C. to 100 cycles based on a 10 millimeter chart amplitude.

The maximum permissible excursion of the pen is limited at high frequencies by the large forces and velocities inherent in such a system. For example, at 100 cps at the specified maximum amplitude of 10 mm peak to peak, the pen tip velocity is about 3000 mm/sec. Under these conditions the acceleration experienced by the pen tip is about 200 times the acceleration of gravity.

PEN PRESSURE

For optimum writing from d.c. to 100 cps, the pen tip pressure should be adjusted to 5/8 gram, ±1/8 gram. This pressure is light enough to produce accurate recordings in the low frequency range from d.c. to 10 cps, and is high enough to produce very legible writing from 10 to 100 cps. If flat response ±1/2 chart line (mm) is desired from d.c. to 10 cps at 10 mm peak to peak, it is recommended that 3/8 gram pen pressure be used. This pressure produces minimum friction and results in improved accuracy of response from d.c. to 10 cps. However, at higher frequencies it is not sufficient pen pressure to prevent hit-skip writing.

If the majority of the recordings are to be made in the range from 10 to 100 cps, a pen pressure of 1¼ grams is recommended. This pressure will write from d.c. to 10 cps, but the high friction involved reduces the linearity of recordings made in this range.

USE OF OSCILLOGRAPH WITH OTHER THAN BRUSH AMPLIFIERS

In using the Brush penmotor with any input other than from Brush amplifiers, precautions must be taken not to exceed a current of 25 milliamperes or 35 volts d.c., or 100 volts a.c. peak to peak.

INK VERSUS ELECTRIC WRITING

There are individual advantages to both ink and electric writing. The method of writing is determined by the type of operation.

Some of the advantages of ink writing are as follows:

a. Better linearity.

b. Trace density is uniform.

c. Ink chart is economical.

d. Good reproductions by photography or most of the many reproduction systems using heat or light such as blueprinting.

Some of the advantages of electric writing are as follows:

a. Unattended operation. This feature is particularly valuable on protracted, unattended operations or where intermittent, unattended operations are necessary.

b. Recording at sub-freezing ambient temperatures.

GENERAL PRECAUTIONS

In general it is well to observe the following precautions when using oscillographs:

a. Keep watches, chronometers and similar instruments away from the oscillograph as their movements may become magnetized.

b. Avoid dropping the oscillograph as it may affect the magnetism of the penmotor.

c. Avoid getting dirt, dust, metal filings, etc., in the penmotor as they may affect the satisfactory operation of the oscillograph.

d. In aligning a penmotor when replacing it, do not tap or hammer it as the penmotor may lose some of its magnetism.

e. If the penmotor becomes damaged in any fashion, do not attempt to repair it as special fixtures are necessary for coil alignment and special equipment is required for proper magnetization. Remove it from the oscillograph and send it to the factory for repair.

ROUTINE SERVICE

LUBRICATION

No lubrication is necessary or desirable as the instrument has been "life-time" lubricated.

TO CLEAN PENS AND INKWELLS

Clogged pens can be cleaned with the Brush Plastic Syringe. The syringe is spring loaded; when the plunger of the syringe is depressed and released, it will return to its original position. To clean a clogged pen, proceed as follows:

1. Remove the PEN and INKWELL from the oscillograph. Fig. 7.
2. Remove the CAPILLARY TUBE from the INKWELL. Do not remove the CAPILLARY TUBE from the PEN. Fig. 7.
3. With the plunger of the syringe depressed, insert the syringe needle into the end of the CAPILLARY TUBE. Continue to hold the plunger depressed.
4. Insert the tip of the PEN (Fig. 8.) into a tumbler of room temperature water and release the plunger. The vacuum thus created will tend to draw water from the outside of the PEN into the syringe.

WARNING

It is important to follow this procedure in using the plastic syringe, since the tip of the pen is tapered on the inside, and water must come from the outside of the pen tip. Water passing through the pen in the wrong direction will cause further clogging in the pen.

The above procedure may be repeated until water enters the PEN or syringe, when the syringe must be removed from the CAPILLARY TUBE and emptied; the cleaning procedure may then be repeated. If this procedure does not clear the PEN, allow PEN to soak overnight in room temperature water and repeat cleaning procedure.

The INKWELLS (Fig. 7.) should be removed from the oscillograph and cleaned periodically to dispose of sediment which collects in the INKWELL. The INKWELLS may be soaked in room temperature water and rinsed thoroughly. The siphon tube in the INKWELL may be rinsed by means of the Brush Plastic Syringe.

TO MEASURE CHART PAPER TENSION

The oscillograph leaves the factory with a chart paper tension of 1 to 1½ pounds. Incorrect chart paper tension results in unsatisfactory recordings. If the tension is too loose the chart paper will not remain flat on the writing surface. If the tension is too tight, it will result in slowing the speed of the chart paper and a consequent error in the time factor of the recording.

To measure the chart paper tension, proceed as follows:

1. Remove the chart paper from between the DRIVE ROLLER and the PRESSURE ROLLER. Fig. 6. Allow the paper to be free on the writing table.
2. Fasten one end of a strip of self-adhering cellophane tape around the hook of a spring scale (customer supplied).
3. Fasten the other end of the tape firmly along the center line of the chart paper in a downward direction.
4. Pull the chart paper by means of the spring scale. As the chart paper unwinds from the SUPPLY ROLL, the scale should indicate from 1 to 1½ pounds tension.

TO ADJUST CHART PAPER TENSION

To adjust chart paper tension, proceed as follows:

1. Insert a hex wrench (provided in tool kit) into the center of the PAPER TENSION ADJUSTMENT. Fig. 12.
2. Loosen the lock nut of the PAPER TENSION ADJUSTMENT while holding the hex wrench to prevent its turning.

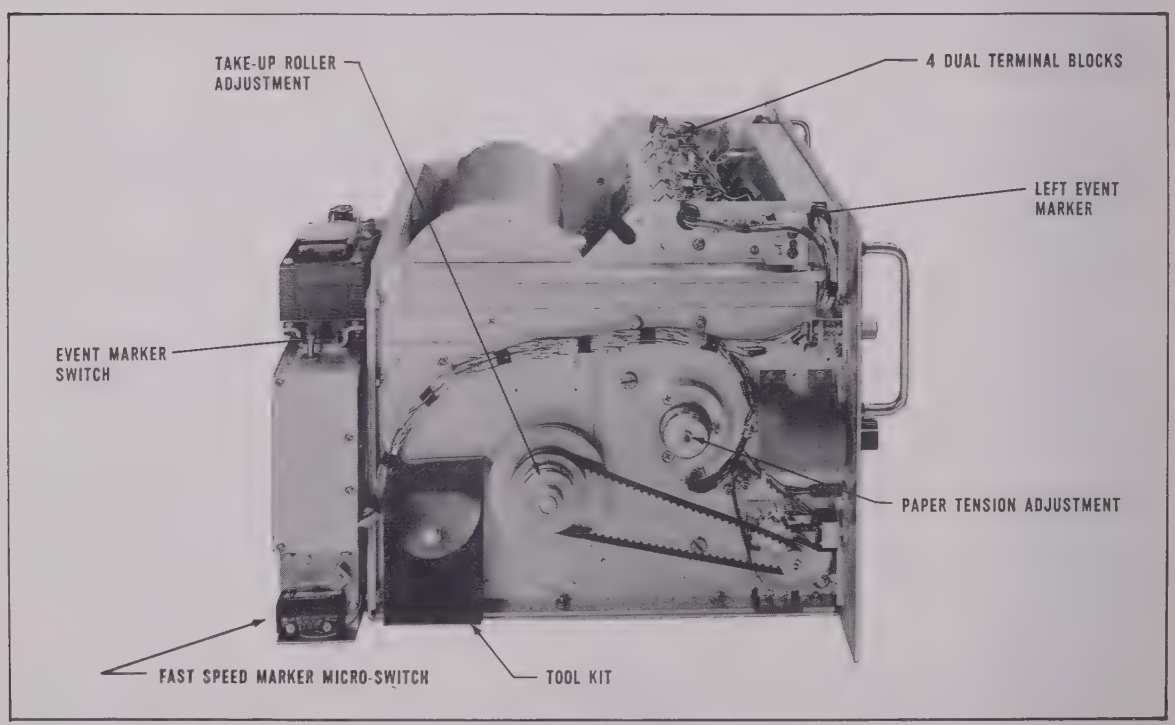


Fig. 12. Left Side of the Six Channel Combination Oscillograph, Model RD 2662 00, Unmounted.

3. Adjust the paper tension by turning the hex wrench in the proper direction while putting tension on the spring scale as described above. (To *increase* tension, turn the hex wrench "in"; to *decrease* tension, "back off" the hex wrench.)
4. After establishing the proper tension with the hex wrench, hold it firmly in exactly the same position and tighten the lock nut.

TO MEASURE AND ADJUST TENSION ON PRESSURE ROLLERS

The PRESSURE ROLLERS (Fig. 9) are adjusted at the factory to exert from 12 to 16 pounds pressure against the DRIVE ROLLER. Fig. 6. Under normal conditions they should not require adjustment. If damaged by accident, due to dropping the instrument, etc., the PRESSURE ROLLERS may be checked in the following manner:

1. Remove the chart paper from between the DRIVE ROLLER and the PRESSURE ROLLER.
2. Restore the PRESSURE ROLLERS to the tension position by means of the PRESSURE ROLLER RELEASE LEVER. The PRESSURE ROLLERS are in tension when the PRESSURE ROLLER RELEASE LEVER is in a horizontal position.
3. Place the hook of a spring scale around the shaft of the PRESSURE ROLLERS at a point near either end of the shaft.
4. Put tension on the spring scale as near as possible directly downward, until the PRESSURE ROLLER on that end of the shaft being measured is tension free of the DRIVE ROLLER. Note the reading on the scale. This reading should be between 12 and 16 pounds. (A scrap of paper placed between the DRIVE ROLLER and the PRESSURE ROLLER will aid in determining when the DRIVE ROLLER is tension free.)
5. Repeat the above step on the opposite end of the PRESSURE ROLLER shaft. The readings on each end must be the same.

If the readings are not within the prescribed limits (12 to 16 pounds) the tension between the DRIVE ROLLER and the PRESSURE ROLLER must be adjusted. This may be accomplished in the following manner:

1. Two hex socket head screws (one for each PRESSURE ROLLER) are provided for tension adjustment of the PRESSURE ROLLERS. They are located on the underside of the oscillograph near the front edge. Access may be had through two circular holes in the bottom plate.
2. Remove the chart paper from between the DRIVE ROLLER and the PRESSURE ROLLER.
3. Restore the PRESSURE ROLLERS to the tension position by means of the PRESSURE ROLLER RELEASE LEVER. The PRESSURE ROLLERS are in tension when the PRESSURE ROLLER RELEASE LEVER is in a horizontal position.
4. Place the hook of a spring scale around the shaft of the PRESSURE ROLLERS at a point near either end of the shaft.
5. Put tension on the spring scale directly downward, until the PRESSURE ROLLER on that end of the shaft being measured is tension free of the DRIVE ROLLER.

6. While holding tension on the spring scale, turn the respective hex socket head screws on the underside of the oscillograph by means of the wrench provided in the tool kit, in the proper direction. Turning the screw "in" *increases* the tension; while "backing off" the screw *decreases* the tension. The left hex socket head screw controls the tension on the left PRESSURE ROLLER and the right hex socket head screw controls the tension on the right PRESSURE ROLLER.
7. Measure the tension on the opposite PRESSURE ROLLER and if necessary, adjust it. Both PRESSURE ROLLERS must have equal tension.

TO ALIGN PENMOTORS

Penmotors are factory aligned. The arc struck by the pen must match the printed arc on the chart paper within ±.005″ measured at full deflection, to meet factory standards. This is a function of the lateral adjustment of the penmotor.

If it is necessary to re-align one or more penmotors, proceed as follows:

1. Disconnect all cables attached to the instrument.
2. Place the instrument on a solid work surface at a convenient height. If rack mounted remove it from the rack.
3. Loosen *very slightly* the two hex socket head screws with which the particular penmotor that is to be adjusted, is mounted on the aluminum support bar. Usually ¼ of a full turn is sufficient.
4. Grasp the penmotor in both hands and move slightly in the proper direction. Do not tap the penmotor with a hammer or any tool as this may affect the magnetism.
5. Test the alignment by gently moving the pens in succession, across the chart paper. The chart paper must be taut on the writing surface.
6. Tighten securely the two hex socket head screws previously loosened.
7. Re-test as in step 5 above. If necessary repeat above alignment procedure.
8. Re-connect all cables to the instrument.

TROUBLE SHOOTING

The chart below lists symptoms and probable causes of improper operation of the oscillograph, or failure of the oscillograph as well as probable remedies for unsatisfactory operation.

The conditions described in the chart are for the Eight and Six Channel Oscillographs, Models RD 2682 00, RD 2662 00, and RD 2661 00, operating from a 105-125v, 60 cps, power source. Procedures suggested in the "Remedy" column may be performed by operating personnel.

SYMPTOM	CAUSE	REMEDY
1. Ink pen writes intermittently.	a. Incorrect pen pressure.	a. Refer to section "To Adjust Pen or Stylus Pressure".
	b. Pen tip not fully in contact with paper.	b. Refer to section "To Lap Pens".
	c. Pen improperly seated in penholder slots.	c. Re-seat pen properly.
2. Ink pen will not write.	a. Lack of ink.	a. Fill inkwell.
	b. Pen not primed.	b. Prime pen. Refer to section "To Fill Inkwells".
	c. Pen clogged.	c. Refer to section "To Clean Pens and Inkwells".
3. Electric stylus writes intermittently or not at all.	a. Excess carbon deposits on stylus.	a. Turn POWER switch "off" and clean stylus.
	b. Incorrect stylus pressure.	b. Refer to section "To Adjust Pen or Stylus Pressure".
	c. Defective flexible lead to stylus.	c. Replace stylus.
	d. TRACE DENSITY switch improperly adjusted.	d. Adjust TRACE DENSITY switch for optimum writing.
	e. Defective rectifier tube.	e. Replace tube.
	f. Filter capacitor "shorted".	f. Replace capacitor.
4. Penmotor inoperative.	a. Lack of proper signal source.	a. Connect to proper signal.
	b. Defective signal cable.	b. Replace or repair cable.
	c. Open penmotor coil.	c. Replace penmotor.
	d. Defective relay.	d. Replace relay.
5. Chart paper drive will not operate.	a. POWER switch not turned "on".	a. Turn POWER switch "on".
	b. LOCAL - STANDBY - REMOTE switch on "STANDBY".	b. Turn LOCAL-STANDBY-REMOTE switch to "LOCAL".
	c. Fuse open.	c. Replace fuse.
	d. Lack of power at source.	d. Connect to proper power source.
	e. Defective power cable.	e. Repair or replace power cable.
	f. Defective motor starting capacitor.	f. Replace capacitor.
	g. Defect in transmission; motor is running.	g. Return transmission to factory for repairs.
	h. Small drive belt broken.	h. Replace drive belt.

SYMPTOM	CAUSE	REMEDY
	i. PRESSURE ROLLER not in tension.	i. Restore tension by means of PRESSURE ROLLER RELEASE LEVER.
	j. Defective relay.	j. Replace relay.
	k. Defective drive motor.	k. Replace motor.
6. Chart paper speed is not as indicated by CHART SPEEDS switch or does not change properly as CHART SPEEDS switch is changed.	a. Defective transmission.	a. Return transmission to factory for repair.
	b. Defective contacts on CHART SPEEDS switch.	b. Repair or replace switch.
	c. Defective 90v d.c. rectifier.	c. Replace rectifier.
	d. Improper paper tension.	d. Refer to section "To Adjust Chart Paper Tension".
7. Chart paper speed is erratic.	a. PRESSURE ROLLER not adjusted properly.	a. Refer to section "To Measure and Adjust Tension on Pressure Roller".
	b. Erratic transmission.	b. Return transmission to factory for repair.
	c. Excessive drag on TENSION ROLLER.	c. Refer to section "To Adjust TENSION ROLLER".
	d. Variation in frequency of power input.	d. Connect to a power line of stable frequency.
8. Chart paper drifts.	a. Chart paper improperly installed.	a. Refer to "To Load or Change Chart Paper".
	b. Chart paper not re-winding evenly due to improper start of rewind.	b. Refer to section "Internal Rewind".
	c. Uneven adjustment of PRESSURE ROLLER tension.	c. Refer to section "To Measure and Adjust Tension on Pressure Rollers".
9. Excessive paper surge when shifting chart speed.	a. Defective resistor or capacitor in paper surge suppressor.	a. Replace defective component.
10. Marker motors inoperative.	a. Defective relay or contacts on TIMER-EXT switch.	a. Replace defective component.
	b. Defective marker motors.	b. Replace motors.
11. Event marker inoperative.	a. Improper wiring of keying circuit.	a. Refer to section "To Connect Event Markers".
	b. TIMER-EXT switch at wrong position.	b. Place switch at proper position.
	c. Micro switch on marker motor inoperative.	c. Replace switch.
	d. Relay defective.	d. Replace relay.
	e. Open coil on event marker.	e. Replace event marker.
12. Operation of event marker causing transients in amplifier signal circuits.	a. Defective surge suppressor across event marker.	a. Replace surge suppressor.
13. Arc of pen trace does not match arcs printed on chart paper.	a. Improper adjustment of PAPER CENTERING ADJUSTMENT.	a. Refer to section "To Load or Change Chart Paper".
	b. Improper mounting of individual penmotor to support bar.	b. Refer to section "To Align Penmotors".

EXPLODED VIEW PARTS LIST

It is recommended that, for major servicing or repairs, the instrument be returned to the factory service stations where facilities are available to restore it to its original condition. In the event that this is impractical or the repair is of a minor nature, the following parts lists and their accompanying exploded views are designed to assist in servicing and repairing. In order to assure prompt and satisfactory delivery of replacement parts, it is very necessary that you include the following information with your order:

1. The name and serial number of the instrument for which the parts are to be used. For example,
   "Six Channel Combination Oscillograph,
   Model RD 2662 00, Serial No. 123".
2. The following specific information on the desired parts:
   Description
   Value (electrical)
   Brush Part No.

NOTE: Do not use the ITEM NO. or SYMBOL NO. for identifying desired parts on your order.

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH RD 2682 00	RD 2662 00	RD 2661 00
1	Door	317182-501	1	1	1
2	Door Latch	118077-501	1	1	1
3	Writing Table	317192	1	1	1
4	Toggle Switch	121068	2	2	2
5	Pilot Light	126621	1	1	1
6	Rotary Switch	118219	1	1	1
7	Handle and Ferrule	112420	2	2	2
8	Lock	124972-206	2	2	2
9	Toggle Switch	110111	8	6	0
10	Switch Shield	218121	0	1	0
10	Switch Shield	226976-910	1	0	0
11	Resistor	5-115558-823	8	6	0
12	Rotary Switch	117999	1	1	1
13	Door Lock	118076	1	1	1
14	Front Panel	426435-910	0	1	0
14	Front Panel	426452-930	0	0	1
14	Front Panel	326972-910	1	0	0
15	Pressure Roll Lever	113219	2	2	2
16	Torsion Bar	113244	2	2	2
17	Torsion Bar Adjust Lever	117229	2	2	2
18	Pressure Roll Shaft	217767	1	1	1
19	Pressure Roll Retaining Ring	104307-2	8	8	8
20	Pressure Roll Bearing	117906-11	2	2	2
21	Torsion Bar Pivot Block	117227	1	1	1
22	Torsion Bar Block	117225	1	1	1

PARTS LIST (Cont'd)

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH RD 2682 00	RD 2662 00	RD 2661 00
23	Torsion Bar Mounting Plate	217880	1	1	1
24	Pressure Roll Release Bar	113218	1	1	1
25	Pressure Roll Release Lever	111585	1	1	1
26	Sleeve	114226	1	1	1
27	Drive Roll Bearing	1-210761	2	2	2
28	Drive Roll	213213-501	1	1	1
29	Drive Roll Bearing Retainer	113228	2	2	2
30	Rewind Drive Belt	117448	1	1	1
31	Drive Belt	117447	1	1	1
32	Flange	117242	1	1	1
33	Collar	117243	1	1	1
34	Drive Belt Sprocket	217245	1	1	1
35	Stud Gear Bearing	117162	1	1	1
36	Stud Gear Housing	226748	1	1	1
37	Stud Gear	127801	1	1	1
38	Connector	117743-1	2	2	2
39	Connector	117742-1	2	2	2
40	Transmission Gear Pin	4-217274-305	1	1	1
41	Transmission Gear	117148	1	1	1
42	Transmission	216972-501	1	1	1
43	Transmission Spacer	117140	3	3	3
44	Transmission Coupling	117702	1	1	1
45	Coupling Block	117701	1	1	1
46	Motor Coupling	117703	1	1	1
47	Transmission Mounting Plate	117141	1	1	1
48	Motor	317713-2	1	1	1
49	Motor Mounting Strap	217433	1	1	1
50	Terminal Strip	100184-3	1	1	1
51	Paper Guide Shaft	113229	2	2	2
52	Guide Shaft Screw	113230	4	4	4
53	Tension Clutch Housing	113245	1	1	1
54	Tension Clutch Disk	113249	1	1	1
55	Tension Clutch Spring	113602	1	1	1
56	Tension Clutch Pin	113250	1	1	1
57	Friction Plate	113252	3	3	3
58	Friction Plate	113251	2	2	2
59	Tension Clutch Mounting Plate	113247	1	1	1
60	Tension Roll Bearing	1-210761-1	2	2	2
61	Tension Roll	213256-501	1	1	1
62	Tension Roll Bearing Retainer	113227	2	2	2
63	Rewind Clutch Collar	117177	1	1	1
64	Rewind Clutch Thrust Washer	127604	1	1	1
65	Rewind Clutch Spring	117410	1	1	1
66	Rewind Clutch Plate	117985-501	1	1	1
67	Rewind Clutch Plate	117198-501	1	1	1
68	Rewind Clutch Plate Pin	1-112468-8	1	1	1
69	Rewind Shaft Bearing	1-210761-3	2	2	2
70	Rewind Shaft Housing	213312	1	1	1
71	Rewind Shaft Hub	117818-501	2	2	2
72	Rewind Shaft Retaining Ring	104307-7	1	1	1

PARTS LIST (Cont'd)

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH RD 2682 00	RD 2662 00	RD 2661 00
73	Rewind Shaft	217909	1	1	1
74	Paper Supply Mounting Plate	117683	2	2	2
75	Paper Supply Retaining Ring	104307-7	2	2	2
76	Paper Supply Indicator	219541-501	1	1	1
77	Paper Supply Shaft	117751	1	1	1
78	Paper Supply Hub	117833-501	1	1	1
79	Paper Supply Adjusting Plate	117694	1	1	1
80	Paper Supply Adjusting Nut	117749	1	1	1
81	Paper Supply Adjusting Screw	117752	1	1	1
82	Left Mounting Bracket	217899	1	1	1
83	Plate	217741	1	1	1
84	Penmotor Mounting Block	117221	0	2	2
85	Left Side Plate	417283	1	1	1
86	Right Side Plate	417267	1	1	1
87	Right Mounting Bracket	222252	1	1	1
88	Pen for Ink Writing (Standard)	RA 2821 30	8	6	6
88	Pen for Ink Writing (Fine Line)	RA 2811 30	0	0	0
88	Stylus for Electric Writing (Standard)	RA 2822 30	8	6	0
89	Ink Tubing (3 Ft.)	126270	0	0	0
90	Pen Lifter	213317	1	1	1
91	Penmotor Connector	126001-1	8	6	6
92	Washer	2-118196-202	1	1	1
93	Pen Lifter Lever	117750	1	1	1
94	Pen Lifter Shaft	117762	1	1	1
95	Pen Lifter Spacer	117764	1	1	1

PARTS LIST (Cont'd)

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH RD 2682 00	RD 2662 00	RD 2661 00
96	Electric Writing Connector	226940-910	6	4	0
97	Penmotor Mounting Bar	327194	0	1	1
97	Penmotor Mounting Bar	326973	1	0	0
98	Penmotor Mounting Bracket, Top	122702	8	6	6
99	Penmotor Mounting Bracket, Bottom	122702	8	6	6
100	Penmotor				
	Channels 1, 6	425939-501-123	0	2	2
	Channels 2, 3, 4, 5	425939-501-108	0	4	4
	Channels 1, 8 428647	~~425939-~~501-115	2	0	0
	Channels 2, 3, 4, 5, 6, 7 428647	~~425939-~~501-098	6	0	0
101	Stopper	6097	8	6	6
102	Inkwell	126052-501	0	6	6
103	Inkwell Holder Assembly	327574	0	1	1
104	Paper Chute	313320	1	1	1
105	Back and Bottom Plate	426489	1	1	1
106	Capacitor	317713-3	1	1	1
107	Writing Bar	317193	1	1	1
108	Paper Tension Arm	123148-501	1	1	1
109	Tool Kit	126438-PL1	1	1	1
142	Inkwell Retaining Strip	328379	0	1	1

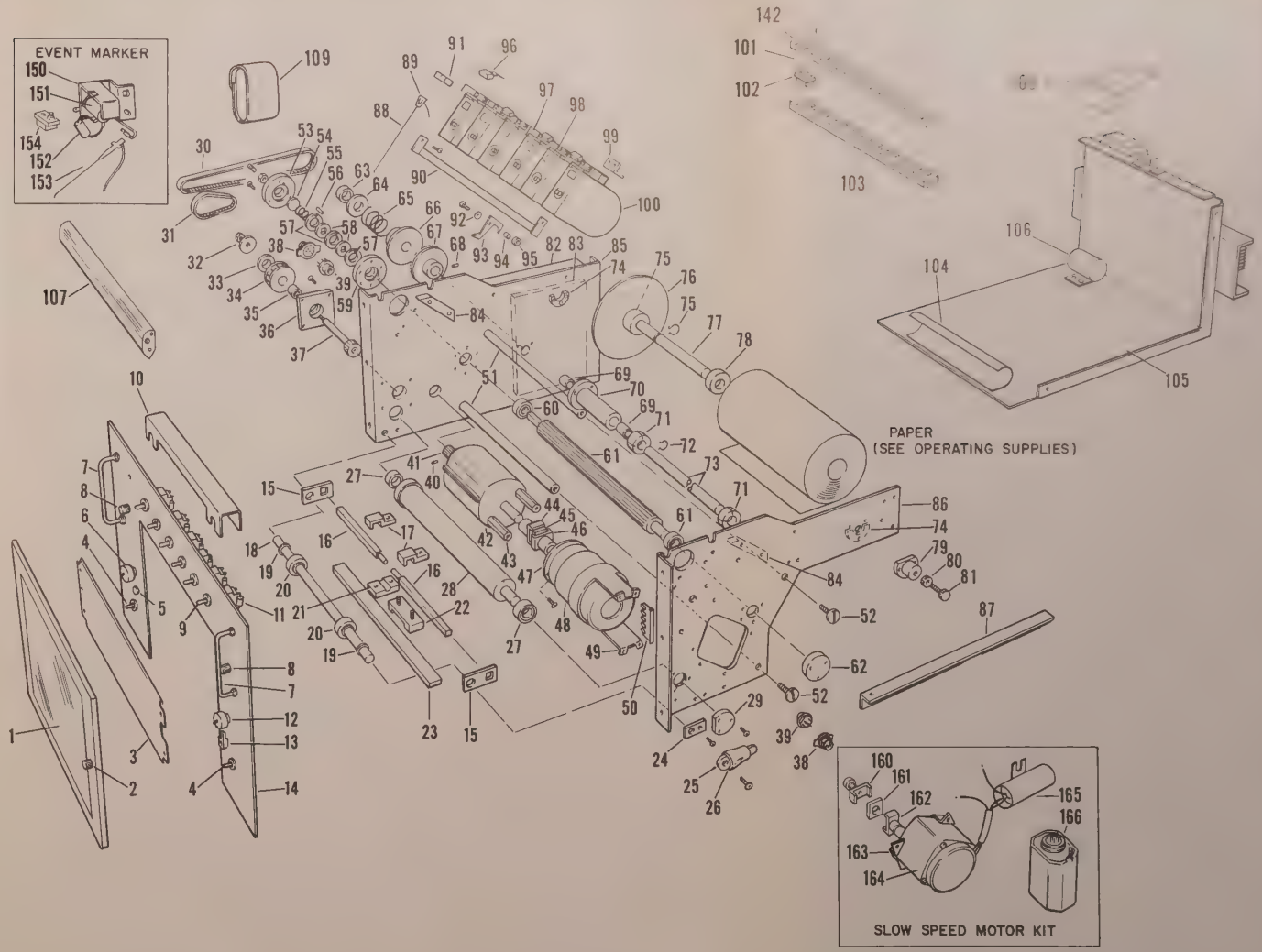
Accessory Left and Right Event Markers — RA 2103 21 (Left) and RA 2103 22 (Right)

For 6 Channel Units, RA 2103 51 (Left) and RA 2103 52 (Right) For 8 Channel Units

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER EVENT MARKER RA 2103 21	RA 2103 22	RA 2103 51	RA 2103 52
150	Bracket	126610	1	0	0	0
150	Bracket	126609	0	1	0	0
150	Bracket	127004	0	0	1	0
150	Bracket	127003	0	0	0	1
151	Relay and Penholder	126225-501	1	0	0	0
151	Relay and Penholder	126226-501	0	1	0	0
151	Relay and Penholder					
	Relay	127797	0	0	1	1
	Penholder Support	127796	0	0	1	0
	Penholder Support	127795	0	0	0	1
	Penholder	127798	0	0	1	1
152	Surge Suppressor (Part of 151)	114147-5	1	1	1	1
153	Pen	RA 2821 30	1	1	1	1
154	Inkwell	126052-501	1	1	0	0
154	Inkwell	128505-910	0	0	1	1

Accessory Slow Speed Motor Kit—RA 2102 20

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH
160	Clutch Assembly—Overriding	222457-501	1
161	Coupling Core	117701	1
162	Slow Motor Coupling	117703	1
163	Mounting Bracket	217256	1
164	Motor	218185-501	1
165	Capacitor and Strap	Part of 164	1
166	Relay	117798	1


EVENT MARKER
150
151
154
152
153
PAPER
(SEE OPERATING SUPPLIES)
SLOW SPEED MOTOR KIT

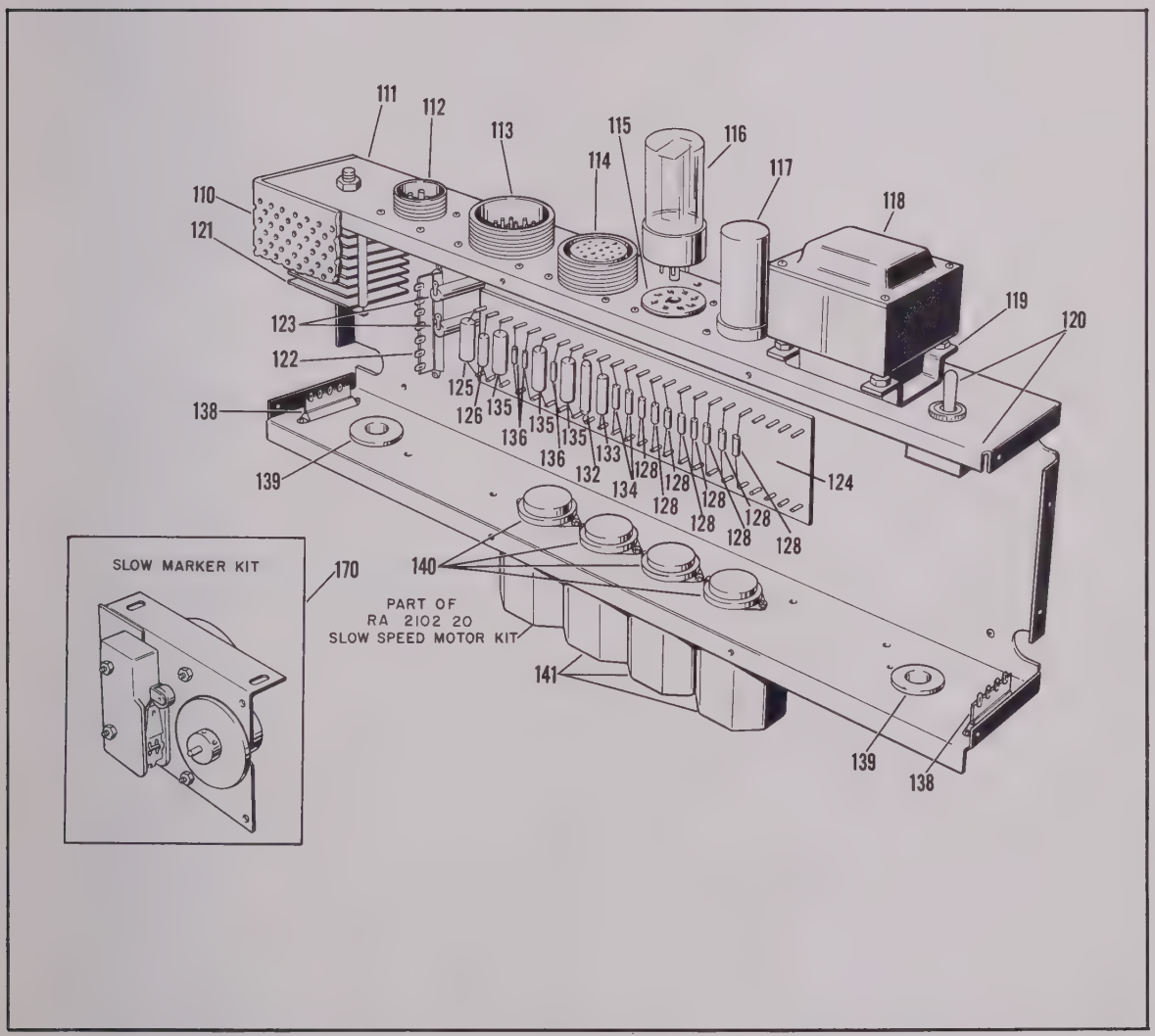
ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH RD 2682 00	RD 2662 00	RD 2661 00
110	Cover	425359	1	1	1
111	Chassis	426442	1	1	1
112	Power Connector	120283	1	1	1
113	Signal Connector	121355	1	1	1
114	Remote Connector	121048	1	1	1
115	Tube Socket	102168-1	1	1	0
116	Tube	102705-1	1	1	0
117	Capacitor and Mounting Plate	100-117717-156	1	1	0
118	Transformer	113128	1	1	0
119	Bracket	117287	2	2	0
120	Toggle Switch	113847	1	1	1
121	Rectifier	113868	1	1	1
122	Terminal Strip	100184-5	1	1	1
123	Fuse Holder	109669	2	2	2
124	Terminal Board	227367-910	1	0	0
124	Terminal Board	217774-501	0	1	1
125	Capacitor	100-117681-106	1	1	1
126	Resistor	5-115559-473	1	1	1
128	Resistor	5-115559-683	8	6	0
132	Resistor	10-119370-251	1	1	0
133	Resistor	10-118180-503	1	1	0
134	Resistor	5-115558-154	2	2	0
135	Capacitor	100-117681-106	3	3	3
136	Resistor	5-115557-472	3	3	3
138	Terminal Strip	100184-2	2	2	2
139	Grommet	123108-72	2	2	2
140	Relay Socket	119757-1	4	3	3
141	Relay	117798	3	2	2

Accessory Slow Marker Kit—RA 2101 20

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH
170	Slow Marker (Motor and Microswitch—One Assembly)	217849-501	1

Accessory Fast Marker Kit—RA 2101 10

ITEM NO.	DESCRIPTION	BRUSH PART NO.	QUANTITY PER OSCILLOGRAPH
170	Fast Marker (Motor and Microswitch—One Assembly)	217848-501	1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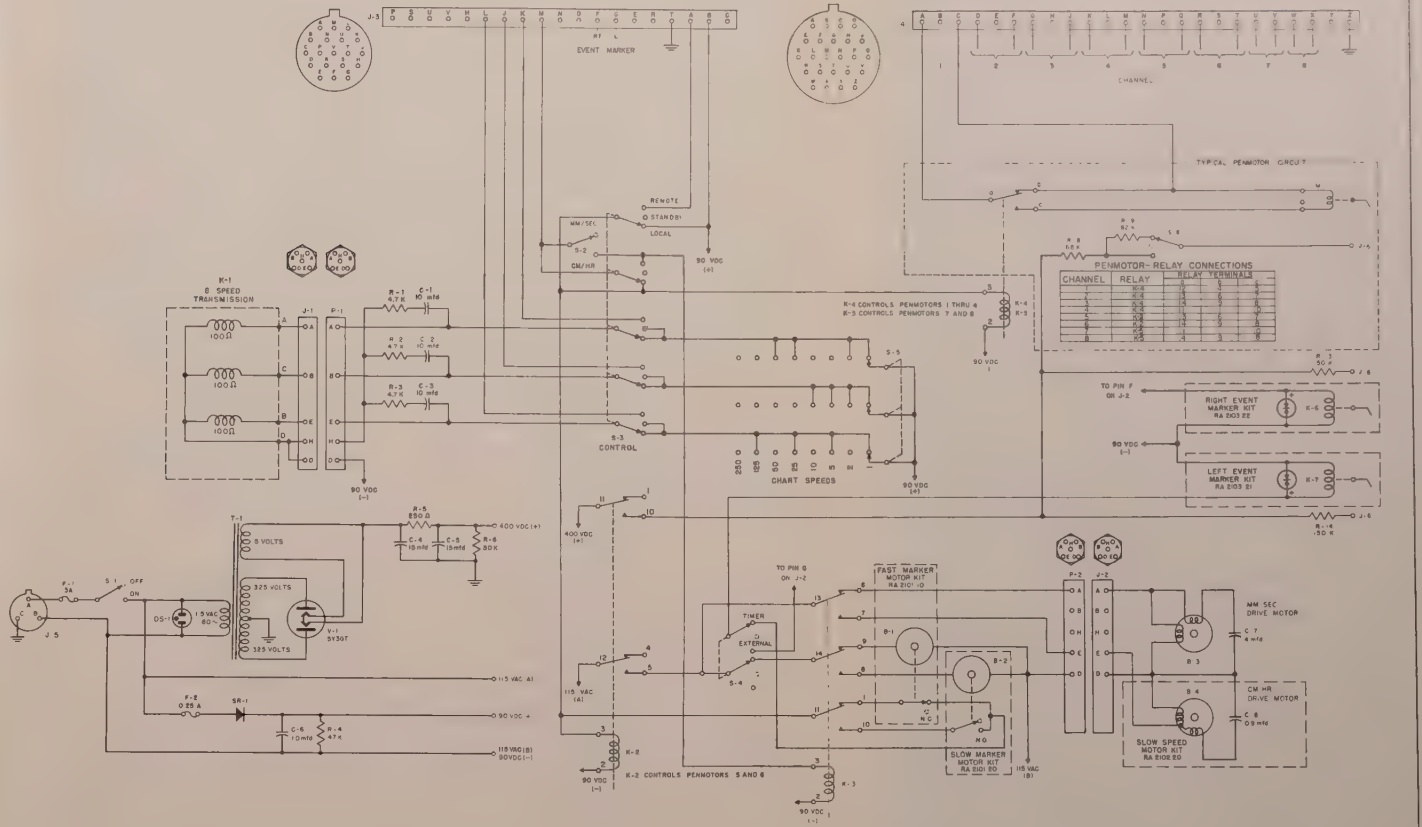
124
SLOW MARKER KIT
170
140
PART OF
RA 2102 20
SLOW SPEED MOTOR KIT
141
139
138

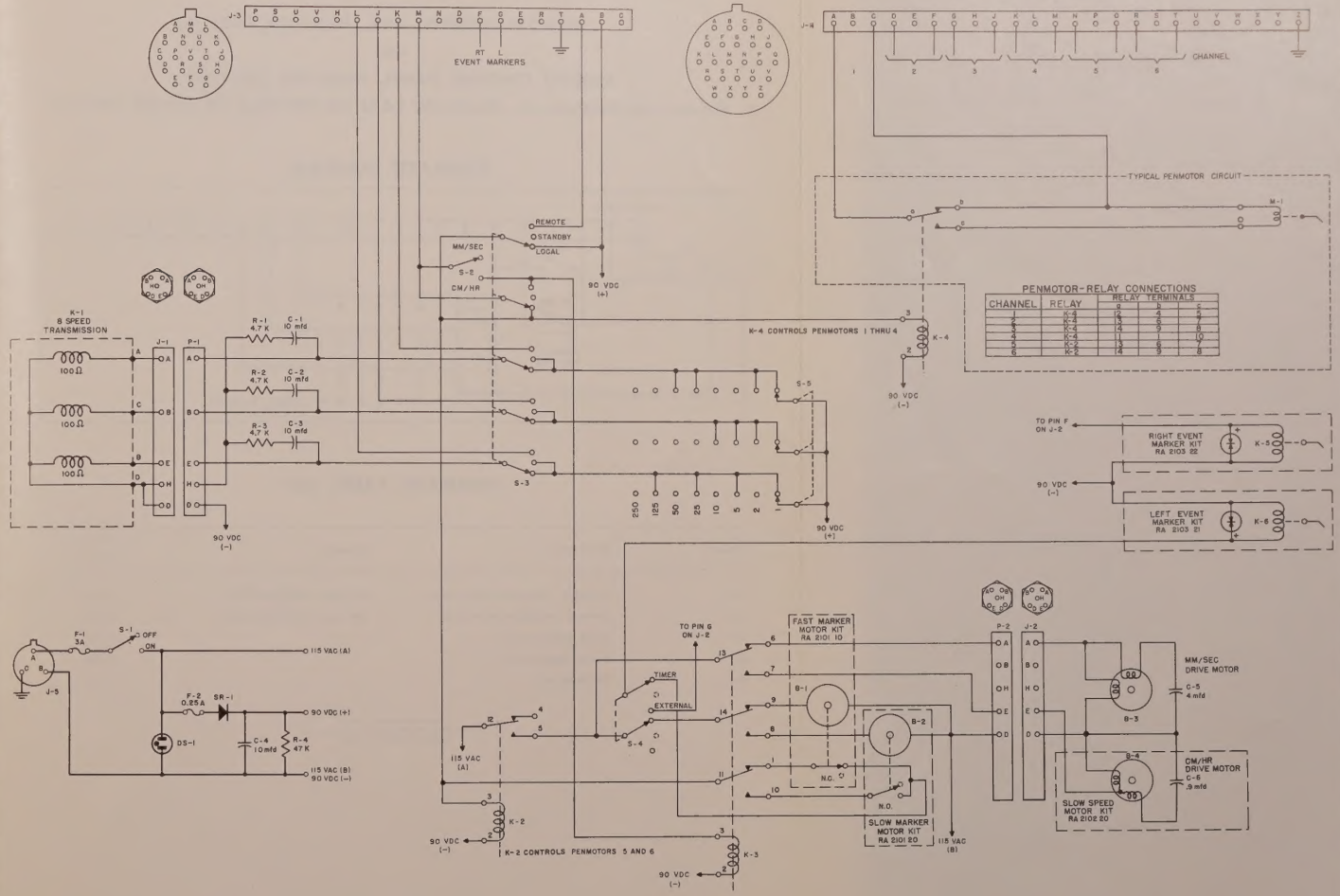
SCHEMATIC PARTS LIST, Models RD 2682 00 and RD 2662 00

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
B-1	Motor, Fast Marker (Includes Microswitch)	(Part of RA 2101 10, Fast Marker Motor Kit)	217848-501
B-2	Motor, Slow Marker (Includes Microswitch)	(Part of RA 2101 20, Slow Marker Motor Kit)	217849-501
B-3	Motor, Fast Speed		317713-2
B-4	Motor, Slow Speed	(Part of RA 2102 20, Slow Speed Kit)	218185-501
C-1	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-2	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-3	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-4	Capacitor, Electrolytic (½ Dual Section)	15 mfd, 450V	100-117717-156
C-5	Capacitor, Electrolytic (½ Dual Section)	15 mfd, 450V	Part of C-4
C-6	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-7	Capacitor, Paper	4 mfd, 330V	317713-3
C-8	Capacitor, Paper	.9 mfd, 220V	Part of B-4
DS-1	Neon Lamp		126621
F-1	Fuse	Type 3AG, "Slo-Blo", 3A, 125V	116198-13
F-2	Fuse	Type 3AG, "Slo-Blo", ¼A, 125V	116198-6
J-1	Connector, Receptacle, Male, 5 Pin		117742-1
J-2	Connector, Receptacle, Male, 5 Pin		117742-1
J-3	Connector, Receptacle, Female, 19 Pin	AN Type—AN-3102A-22-14S	121048
J-4	Connector, Receptacle, Male, 24 Pin	AN Type—AN-3102A-14-28P	121355
J-5	Connector, Receptacle, Male, 3 Pin	AN Type—AN-3102A-16-10P	120283
J-6	Connector, Receptacle, Female, 2 Pin		113316-501
K-1	Transmission		216972-501
K-2	Relay	4 P.D.T.	117798
K-3	Relay	(Part of RA 2102 20, Slow Speed Kit)	117798
K-4	Relay	4 P.D.T.	117798
K-5	Relay	4 P.D.T.	117798
K-6	Relay, Marker Coil	(Part of RA 2103 22, Right Event Marker Kit)	116832
K-7	Relay, Marker Coil	(Part of RA 2103 21, Left Event Marker Kit)	116832
M-1	Penmotor (RD 2682 00)		
	Channels 1, 8		425939-501-115
	Channels 2, 3, 4, 5, 6, 7		425939-501-098
M-1	Penmotor (RD 2662 00)		
	Channels 1, 6		425939-501-123
	Channels 2, 3, 4, 5		425939-501-108
P-1	Connector, Plug, Female, 5 Pin		117743-1
P-2	Connector, Plug, Female, 5 Pin		117743-1
R-1	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-2	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-3	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-4	Resistor, Composition	47K, ± 5%, 2W	5-115559-473
R-5	Resistor, Wire Wound	250 ohms, ± 5%, 5W	10-119370-251
R-6	Resistor, Wire Wound	50K, ± 5%, 10W	10-118180-503
R-8	Resistor, Composition	68K, ± 5%, 2W	5-115559-683
R-9	Resistor, Composition	82K, ± 5%, 1W	5-115558-823
R-13	Resistor, Composition	150K, ± 5%, 1W	5-115558-154
R-14	Resistor, Composition	150K, ± 5%, 1W	5-115558-154
S-1	Switch, Toggle	S.P.S.T.	121068
S-2	Switch, Toggle	S.P.S.T.	121068
S-3	Switch, Rotary		118219
S-4	Switch, Toggle	D.P.D.T. (Center Off)	113847
S-5	Switch, Rotary		117999
S-8	Switch, Toggle	S.P.D.T. (Center Off)	110111
SR-1	Rectifier		113868
SU-1	Surge Suppressor	(Part of RA 2103 22, Right Event Marker Kit)	114147-5
SU-2	Surge Suppressor	(Part of RA 2103 21, Left Event Marker Kit)	114147-5
T-1	Transformer		113128
V-1	Tube, Electron	5Y3GT	102705-1


EVENT MARKER
REMOTE
STANDBY
LOCAL
MM/SEC
CM/HR
S-2
90 VDC (+)
K-1
8 SPEED TRANSMISSION
100Ω
100Ω
100Ω
R-1 4.7K
R-2 4.7K
R-3 4.7K
C-1 10 mfd
C-2 10 mfd
C-3 10 mfd
90 VDC (-)
S-3
CONTROL
K-4 CONTROLS PENMOTORS 1 THRU 4
K-5 CONTROLS PENMOTORS 7 AND 8
S-5
CHART SPEEDS
CHANNEL
TYPICAL PENMOTOR CIRCUIT
PENMOTOR-RELAY CONNECTIONS
CHANNEL
RELAY
RELAY TERMINALS
TO PIN F ON J-2
RIGHT EVENT MARKER KIT RA 2103 22
K-6
LEFT EVENT MARKER KIT RA 2103 21
K-7
T-1
6 VOLTS
325 VOLTS
325 VOLTS
R-5 850 Ω
C-4 15 mfd
C-5 15 mfd
R-6 30K
400 VDC (+)
F-1 3A
S-1 OFF ON
J-5
DS-1
1.9 VAC 60~
V-1 5Y3GT
115 VAC (A)
F-2 0.25 A
SR-1
C-6 10 mfd
R-4 47K
90 VDC (+)
115 VAC (B) 90 VDC (-)
400 VDC (+)
115 VAC (A)
K-2
90 VDC (-)
K-2 CONTROLS PENMOTORS 5 AND 6
K-3
90 VDC (-)
TO PIN G ON J-2
TIMER
EXTERNAL
S-4
FAST MARKER MOTOR KIT RA 2101 10
B-1
B-2
NC
NO
SLOW MARKER MOTOR KIT RA 2101 20
115 VAC (B)
MM SEC DRIVE MOTOR
B-3
C-7 4 mfd
CM HR DRIVE MOTOR
B-4
C-8 0.9 mfd
SLOW SPEED MOTOR KIT RA 2102 20

SCHEMATIC PARTS LIST, Model RD 2661 00

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
B-1	Motor, Fast Marker (Includes Microswitch)	(Part of RA 2101 10, Fast Marker Motor Kit)	217848-501
B-2	Motor, Slow Marker (Includes Microswitch)	(Part of RA 2101 20, Slow Marker Motor Kit)	217849-501
B-3	Motor, Fast Speed		317713-2
B-4	Motor, Slow Speed	(Part of RA 2102 20, Slow Speed Kit)	218185-501
C-1	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-2	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-3	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-4	Capacitor, Electrolytic	10 mfd, 150V	100-117681-106
C-5	Capacitor, Paper	4 mfd, 330V	317713-3
C-6	Capacitor, Paper	.9 mfd, 220V	Part of B-4
DS-1	Neon Lamp		126621
F-1	Fuse	Type 3AG "Slo-Blo", 3A, 125V	116198-13
F-2	Fuse	Type 3AG, ¼A, 250V	102625-3
J-1	Connector, Receptacle, Male, 5 Pin		117742-1
J-2	Connector, Receptacle, Male, 5 Pin		117742-1
J-3	Connector, Receptacle, Female, 19 Pin	AN Type—AN-3102A-22-14S	121048
J-4	Connector, Receptacle, Male, 24 Pin	AN Type—AN-3102A-24-28P	121355
J-5	Connector, Receptacle, Male, 3 Pin	AN Type—AN-3102A-16-10P	120283
K-1	Transmission		216972-501
K-2	Relay	4 P.D.T.	117798
K-3	Relay	(Part of RA 2102 20, Slow Speed Kit)	117798
K-4	Relay	4 P.D.T.	117798
K-5	Relay, Marker Coil	(Part of RA 2103 22, Right Event Marker Kit)	116832
K-6	Relay, Marker Coil	(Part of RA 2103 21, Left Event Marker Kit)	116832
M-1	Penmotor		
	Channels 1, 6		425939-501-123
	Channels 2, 3, 4, 5		425939-501-108
P-1	Connector, Plug, Female, 5 Pin		117743-1
P-2	Connector, Plug, Female, 5 Pin		117743-1
R-1	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-2	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-3	Resistor, Composition	4.7K, ± 5%, ½W	5-115557-472
R-4	Resistor, Composition	47K, ± 5%, 2W	5-115559-473
S-1	Switch, Toggle	SPST	121068
S-2	Switch, Toggle	SPST	121068
S-3	Switch, Rotary		118219
S-4	Switch, Toggle	D.P.D.T. (Center Off)	113847
S-5	Switch, Rotary		117999
SR-1	Rectifier		113868
SU-1	Surge Suppressor	(Part of RA 2103 22, Right Event Marker Kit)	114147-5
SU-2	Surge Suppressor	(Part of RA 2103 21, Left Event Marker Kit)	114147-5

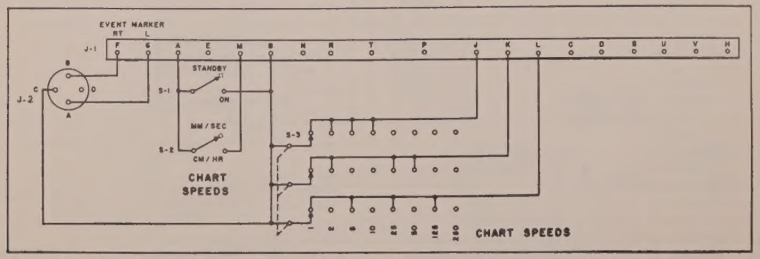


PENMOTOR-RELAY CONNECTIONS

CHANNEL	RELAY	RELAY TERMINALS		
		a	b	c
1	K-4	12	4	9
2	K-4	13	5	7
3	K-4	14	9	8
4	K-4	11	1	10
5	K-2	13	6	7
6	K-2	14	9	8

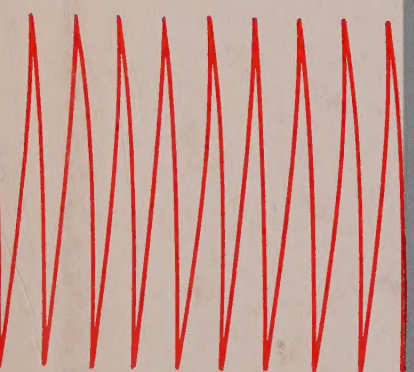
REMOTE CONTROL BOX, Model RA 2403 03
and
REMOTE CONTROL PANEL, Model RA 2403 04
For use with Oscillographs, Models RD 2682 00, RD 2662 00, and RD 2661 00

SCHEMATIC DIAGRAM



SCHEMATIC PARTS LIST

SYMBOL	DESCRIPTION	REMARKS	BRUSH PART NO.
J-1	Connector, Receptacle, Female, 19 Pin	AN Type—AN-3102A-22-14P	121047
J-2	Connector, Receptacle, Male, 4 Pin	AN Type—AN-3102A-14S-2S	122099
S-1	Switch, Toggle S.P.S.T.		121068
S-2	Switch, Toggle S.P.S.T.		121068
S-3	Switch, Rotary		117999



brush INSTRUMENTS
DIVISION OF
3405 PERKINS AVENUE CLEVITE CORPORATION CLEVELAND 14, OHIO

MP MASTER
MA34681